

**PIER – Energy Systems Integration
Technical Review
November 21-22, 2002
AGENDA**

1. Introductions (*All*)
2. PIER Overview (*Terry Surles*)
3. Agenda/Binder Overview (*Laurie ten Hope*)
4. ESI Vision & Issues (*Laurie ten Hope*)
5. ESI Portfolio Overview (*Laurie ten Hope*)
 - Program Area History – 3 phases
 - Current Program
 - 4 Focus Areas – rationale, issues, strategy, stakeholders
 - Collaborations
 - Committee Questions and Discussion
6. Break
7. Distributed Energy Resources (*Mark Rawson*)
 - Context, Vision, Issues
 - Policy Relevance
 - Research Assessment & Roadmap
 - Coordination & Leverage
 - 2 Featured Projects (*DUIT – Bill Erdmann; New Power Technology - Peter Evans*)
 - Future Plans
 - Committee Questions and Discussion
8. Working Lunch
9. Demand Response (*Ron Hofmann*)
 - Context, Vision, Issues
 - Policy Relevance
 - Research Assessment & Roadmap
 - Coordination & Leverage
 - 2 Featured Projects (*C&I Case Studies – Karen Herter; DR Enabling Technologies – Cliff Federspiel*)
 - Future Plans
 - Committee Questions and Discussion
10. Break
11. Transmission (*Linda Kelly*)
 - Context, Vision, Issues
 - Policy Relevance
 - Research Assessment & Roadmap
 - Coordination & Leverage
 - 3 Featured Projects (*The Valley Group - Don Kondoleon; CERTS - Joe Eto; SLIM - David Chambers*)
 - Future Plans
 - Committee Questions and Discussion
12. Strategic Systems (*Laurie ten Hope*)
 - Context, Vision, Issues
 - 1 Featured Project (*AESC - Jamie Patterson*)
 - Future Plans
 - Committee Questions and Discussion
13. Wrap-Up (*All*)

PIER Energy Systems Integration, Team Bios, Full-time staff.

Laurie ten Hope (Energy Commission Specialist III)



Laurie ten Hope currently manages the Energy Systems Integration research program at the California Energy Commission. Ms. ten Hope leads a multi-disciplinary team in the development of research initiatives to improve electricity infrastructure efficiency and reliability, integrate distributed resources, develop demand response tools, and improve transmission efficiency.

Previously, Ms. ten Hope served 6 years as Advisor to two CEC Commissioners. She prepared analysis and advised Commissioners on economic and environmental impacts of programs and legislation. She has briefed Members of the Legislature, Secretary of Resources and the Governor's Office on Commission policy recommendations. Prior to that, Ms ten Hope supervised the Commission's efficiency building standards' training and education programs. Prior to joining the CEC, Ms. ten Hope held various commercial energy efficiency positions at Pacific Gas & Electric Co.

Ms. ten Hope serves on the Advisory Board of the Center for the Study of Energy Markets and is a member of Women Energy Associates. Ms. ten Hope has a Bachelor of Arts in Environmental Science from the State University of New York.

Mark Rawson (Energy Commission Specialist II)



Expertise: I have a degree in mechanical engineering with focus in control systems and data acquisition and a minor in mathematics from California State University, Chico. I graduated in 1989 and began working for Port Hueneme Naval Surface Warfare Center in Port Hueneme, CA. I provided in-service engineering to support the Navy's DD, DDG and CG Cruiser and Destroyer class ships. Specifically, I worked on Tomahawk, Standard and ASROC missile launch systems. My primary duties were failure analysis of electro-mechanical devices, test system and procedure development, quality control and training.

My career with the Energy Commission began in 1995 in the Transportation Technology and Fuels Office. The bulk of my duties were commercialization and demonstration oriented with some research and development work. Initially, I was responsible for developing a procedure manual for the operation, maintenance, inspection and troubleshooting of the Methanol Fueling System Demonstration Program. I developed and implemented two first-of-a-kind training programs; one program for building officials on installation practices for electric vehicle charging systems and the other for emergency response personnel on dealing with electric vehicle accidents. I also managed

a research project with Georgia Institute of Technology to determine the impacts of electric vehicle chargers on residential secondary distribution systems.

Assigned Responsibilities: Energy Systems Integration Program Area Research Plan, leading development of the Strategic DER Research Plan, DER Interconnection Working Group Technical Support and other ESI Program duties as required.

Linda Kelly (Energy Commission Specialist II)



Linda Kelly is leading the effort to develop an ESI transmission R&D plan and is developing a regional approach to address multiple system constraints in the San Francisco Area. Prior to joining the ESI team, Ms. Kelly worked for 13 years in the Energy Commission Electric Systems Analysis Office. During that time she utilized production cost models to analyze how electric generation systems in California and the West operate, as well as develop supply forecasts for utilities operating in California. She also had responsibility for studying and developing information on variety of subjects having to do with electric industry restructuring, electric system operation, electric generation need assessment, emission dispersion, hydro system capacity, system resource characterizations, municipal utilities, and demand /supply balances.

When the electric generation industry was restructured, Ms. Kelly was responsible for developing a Commission process, as directed in AB 1890, to award Competitive Transmission Cost exemptions to Irrigation Districts throughout the state. Ms. Kelly also conceptualized, developed and ran the Energy Cooperative Development program at the Energy Commission. This program enabled a diverse group of California consumers to successfully organize cooperatives that were able to provide members with information on electricity issues and services that enabled them to reduce their energy costs.

Ms. Kelly received a BA degree in Environmental Studies with a minor in Economics from California State University at Sacramento.

Jamie Patterson (Energy Commission Specialist 1)



Expertise: I have a BS degree in Electrical Engineering from San Diego State University 1984. I began my working career as an intern at San Diego Gas & Electric Co. From there I was employed as an Electrical Engineer at AMEX Systems Inc. I have worked as a Sr. Electrical Engineer in the R&D design engineering departments at Bendix Aerospace, Allied Signal, SAIC and Technetics Inc. Before working at the Commission I was an Electrical Utility Consultant at ADM. In this position I traveled across the country working on temporary assignment to various utilities investigating power quality. Part of this research effort was to write a handbook

for the Center for Demand Side Research on ASDs. I have also written papers on power quality for ASHRAE and CEED/EPRI conferences. I started working at the Energy Commission in 1994 and have worked fairly consistently in the research, development and demonstration of advanced energy technologies.

Assigned Responsibilities: Manage various PIER research contracts including AESC, Siemens and Trinity Flywheel. Also providing support to the PIER Energy Systems Integration Transmission Plan development effort and managing EPRI Tailored Collaboratives.

David Chambers (Associate Electrical Engineer)



Expertise: I have an AS degree in Math and Physics from American River College 1985, BS degree in Electrical and Electronic Engineering from California State University Sacramento 1992. I began my career as a summer intern at Pacific Gas and Electric Co. 1989. From there I joined Sacramento Municipal Utility District as an engineering student assistant 1990. I joined Bechtel Inc. in 1992 as an Electrical Engineer and worked in the San Francisco H.Q. engineering design group. I worked on a variety of projects; Super-conducting Magnetic Energy Storage (SMES), nuclear power plants (ALWR, ABWR), Space Launch Complex (SLC-3E), and copper ore mining project (La Candelaria). Next, I joined Plant Operations Personal Inc. as a contract field construction Electrical Engineer. I worked on a Clean Fuels Refinery Project. From there I joined Walsh Construction Company, a subsidiary of Guy F. Atkinson Inc. as a Field Electrical Engineer and built Co-generation Power Plants (P&G Co-Gen, UCSF Research Medical Facility Co-Gen.). I then joined Caltrans as a Transportation Engineer (Electrical). I developed, managed and conducted research projects. Next, I joined the California Energy Commission (April 2001) as an Associate Electrical Engineer. I perform contract management and other duties as required.

Assigned Responsibilities: Lead planning effort for storage technologies research, manage various PIER Strategic research contracts, including the Pacific Earthquake Engineering Research Center (PEER) Lifelines program projects, SLIM project and support actives for the PIER Energy Systems Integration R D&D group.

David N. Michel (Energy Analyst)



Mr. David Michel currently serves as PIER Contract Manager for the Distributed Utility Integration Test (DUIT) and FOCUS-Interconnection II projects, which address issues to improve integration of DER into California's electricity system. He is an active member of California's Rule 21 Working Group that deals with streamlining DG interconnection. He also supports the PIER Energy Systems Integration DER Research Planning effort and the Energy

Systems Integration Team. Mr. Michel has been with the CEC since August of 2001. He came to the CEC with over 20 years of private industry contract and project management experience.

Mr. Michel earned his BS from University of California, Davis in Environmental Policy Analysis and Planning with an emphasis in Energy Policy.

David Michel resides in Elk Grove, CA, with his wife Mary where they enjoy running.

Philip Misemer (Energy Commission Supervisor II)



I have a degree in chemistry/biochemistry and a Masters in Business Administration, both from California State University, Bakersfield. I began my working career doing research and development of lubricating oils at Witco Chemical Corp. From there I have directed quality control laboratories in the oil refining, petroleum pipeline and hazardous waste industries. I started my current career incarnation with the Energy Commission in 1986 and have worked fairly consistently in the research, development and demonstration of advanced energy technologies, usually on the energy generation side. I manage the Energy Innovations Small Grant Program, which is a part of the larger Public Interest Energy Research program that is managed by the Energy Commission. I am also a supervisor for the PIER Environmental Subject Area and the PIER Energy Systems Integration Subject Area.

Assigned Responsibilities: Senior supervisor for the research & development technical staff assigned to the PIER Energy Systems Integration and the PIER Environmental Subject Areas, and manage the Energy Innovations Small Grant Program.

PIER Energy Systems Integration, Team Bios, “Adjunct” staff.

Don Kondoleon (Manager of the California Energy Commission’s (CEC) Transmission Evaluation Program)



Don Kondoleon has been the manager of the California Energy Commission’s (CEC) Transmission Evaluation Program for the past fifteen years. Mr. Kondoleon directs a staff responsible for the collection, analysis and dissemination of transmission information, including maps, to interested parties; the representation of the CEC at statewide, regional and national transmission reliability organizations; and, the management of CEC Public Interest Energy Research-funded transmission reliability projects. Mr. Kondoleon provides policy guidance to CEC executive staff and Commissioners on the planning, permitting and operation of the western electricity grid. During the two years, Mr. Kondoleon has been a principal

advisor to the Governor's Office, the Legislature and the Western Governor's Association on transmission related matters. Mr. Kondoleon is also the CEC's representative to the Western Electricity Coordinating Council's Operations Committee.

Prior to his current duties, Mr. Kondoleon directed the Stationary Clean Fuels Program within the CEC's Development Division for five years and managed technology assessment and system modeling projects within the CEC's Assessment Division for five years. Prior to joining the CEC, Mr. Kondoleon was a consultant to the Environmental Protection Agency and the Department of Energy in Washington, D.C.

Mr. Kondoleon's educational background includes a Bachelor of Science degree received through the Environmental Engineering Program of the University of Maryland.

Dr. Michael Jaske (Strategic Issues Integration Group)

Dr. Michael Jaske currently provides support to the Executive Director at the California Energy Commission (CEC) as a member of the Strategic Issues Integration Group. For 20 years he was the Chief Demand Forecaster giving technical direction for the Commission Staff's independent demand forecast. Dr. Jaske plays an active role in the development and advocacy of the CEC's positions on retail market structure. A current focus is on developing dynamic pricing tariffs and their integration into utility procurement activities. Dr. Jaske also provides support to PIER research in retail market topics.

Dr. Jaske has testified numerous times before the CEC, the California Public Utilities Commission, and the California legislature. He frequently speaks on retail market structure issues at conferences and symposia. Dr. Jaske is a member of the IEEE Power Engineering Society. Dr. Jaske serves on the Energy Policy Committee of IEEE-USA to educate national policymakers on electricity issues.

Dr. Jaske's educational background includes a BS in Chemical Engineering from Oregon State University, and a MS and Ph.D. in Systems Science, both from Michigan State University.

McKinley Addy (Mechanical Engineer)



McKinley Addy is a project manager and mechanical engineer in the Transportation Energy Division of the California Energy Commission. He has over 13 years of broad and in depth experience researching, developing and commercializing numerous advanced transportation technologies, analyzing their impact on California transportation energy demand and use, as well as electric power systems planning, operation and maintenance for the U.S. Department of Energy. He manages the ESI project to assess the power quality impacts from the use of electric transportation equipment at selected California airports.

Ron Hofmann (Consultant)

Ron Hofmann is an independent consultant specializing in business development and technology assessment in the energy sector. Mr. Hofmann has extensive experience in developing new businesses and markets from the ground up. Currently, he sits on two Boards and is an advisor to several emerging energy-related technology companies. Also, through the University of California, he is helping the California Energy Commission's PIER program develop RD&D projects.

Over the past 40 years, Mr. Hofmann has started several successful enterprises. He was a co-founder in 1983 (and the original CEO for 12 years) of EnergyLine Systems, Inc. EnergyLine, currently a subsidiary of S&C Electric, is a provider of communicating automation solutions for applications on both sides of the power revenue meter.

Mr. Hofmann has a mechanical engineering degree from the University of California in Berkeley and did post-graduate studies in thermo sciences at the University of Wisconsin in Madison. For many years, he was an active (and charter) participant in the CEO Forum sponsored by the Santa Clara University Business School. In his career, he held technical, marketing, sales, and management positions in large and small companies. Mr. Hofmann's consulting practice is located in Oakland, California.



ESI Technical Review Presentation

Terry Surles, Ph.D.

PIER Program Manager

California Energy Commission

November 21, 2002



PIER Program Legislative History

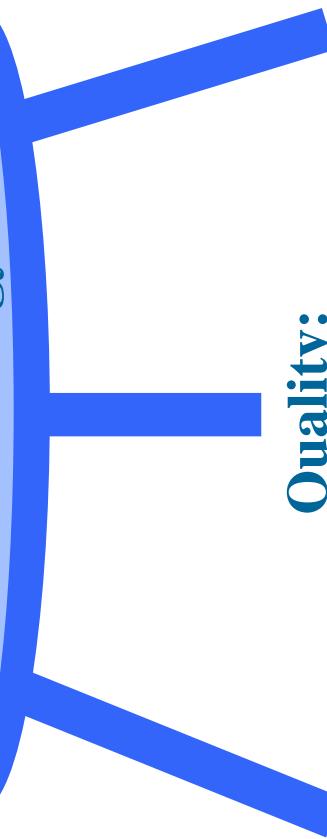
- ◆ AB 1890, the Electricity Deregulation Bill, (September 1996) established a new policy (Public Goods Charge) to support
 - public interest energy research (CEC/PIER),
 - renewable market support (CEC/Renewables), and
 - energy efficiency market support (CPUC)
- ◆ SB 90 (November 1997) created the Public Interest Energy Research Trust Fund
- ◆ AB 995/SB 1194 (September 2000) continued PIER program for another 10 years (through 2011) at \$62.5 M/yr.



pier

California has Established a \$62M/yr Public Interest Energy Research Program (PIER)

California's Energy Future



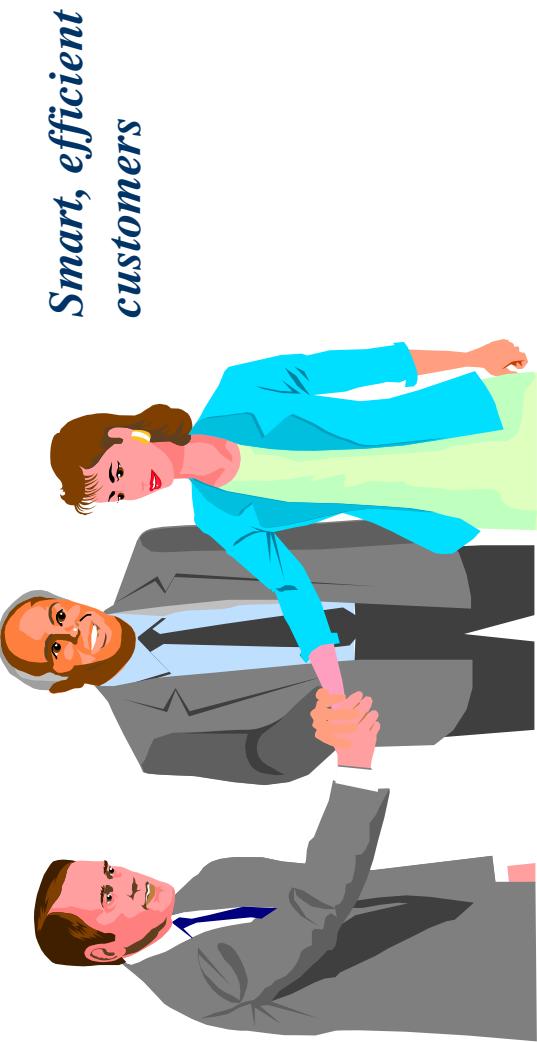
Quality:
Reliable and **Environment:**
Protect and
Enhance

Economy:
Affordable
Solutions



Vision Statement

The future electrical system of California will provide a **clean, abundant and affordable supply** tailored to the needs of “smart”, efficient customers and will be the best in the nation.

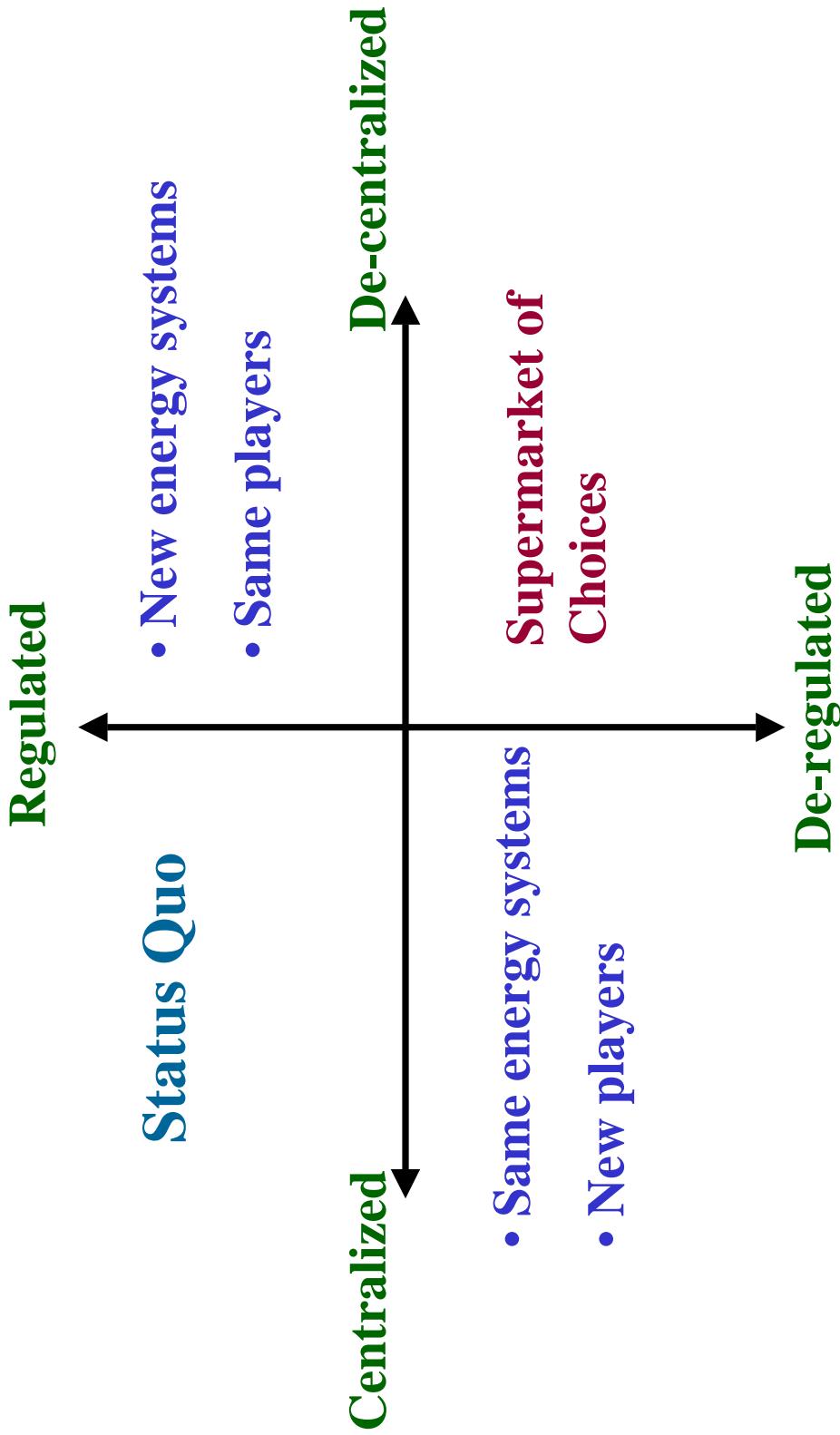


*Tailored,
clean,
abundant,
affordable
supply*

*Smart, efficient
customers*



Our R&D Program Should Impact the Future Energy Marketplace

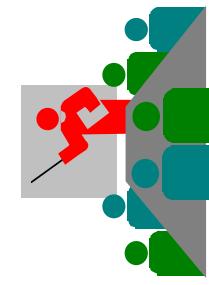


Another Approach, Scenario Development, for Focusing Efforts

Scenario 1

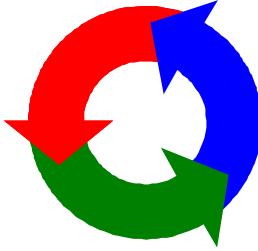
Controlled/Average Pricing

GOVERNMENT GREENS



- Government policy leads
- Environment a priority
- Energy as a necessity
- Gov't directed technology

SUMMER OF 2001 LOOP



- Contentious policy battles
- Energy as a necessity
- Market instability/lumpy investments

Environmental needs not key

INFORMED ENERGY



- Energy as a product you buy
- Technology options give choices
- Prices transparent to inform
- Government helps markets develop

•Environmental concerns imbedded in markets

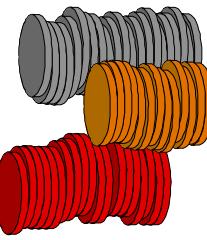
Scenario 3

Prepared by Global Business Network (GBN)

Transparent/Dynamic Pricing

Scenario 2

Low environmental priority



MARKET COMPETITIVE ENERGY

- Lowest cost energy wins
- Energy as a product you buy
- Technology choices limited by economics
- Environment indirectly addressed by markets

Scenario 4

CALIFORNIA ENERGY COMMISSION



PIER Mission

The Mission of the PIER program is to conduct public interest energy research that seeks to improve the quality of life for California's citizens by providing environmentally sound, safe, reliable and affordable energy services and products.

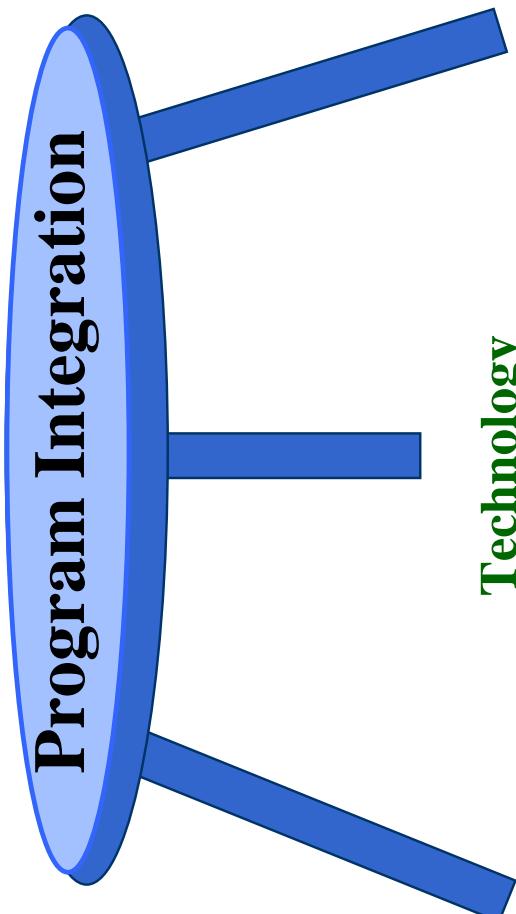


PIER Public Benefit Objectives

- ♦ Improve energy cost/value
- ♦ Improve environment, public health, and safety
- ♦ Improve electricity reliability/quality/sufficiency
- ♦ Strengthen the economy
- ♦ Provide consumer choice

We are using Decision Analysis to improve quantitative understanding of how PIER is meeting these objectives

Attributes for Addressing State Issues



- Universities
- Industry
 - Federal
 - State
 - Local
- Temporal
- Technology
- Risk

Focus on
California

- Specific to
State needs





California Must be Prepared to Face the Same Issues as Others

◆ Economics

- Resource Competition
- New technology market penetration
- Lifecycle analysis

◆ Environment

- Local regional and global impact
- Climate change
- Sustainable practices

◆ Systems

- Peak demand
- Infrastructure integration

Energy Costs Fundamentally Affect our Overall Economy



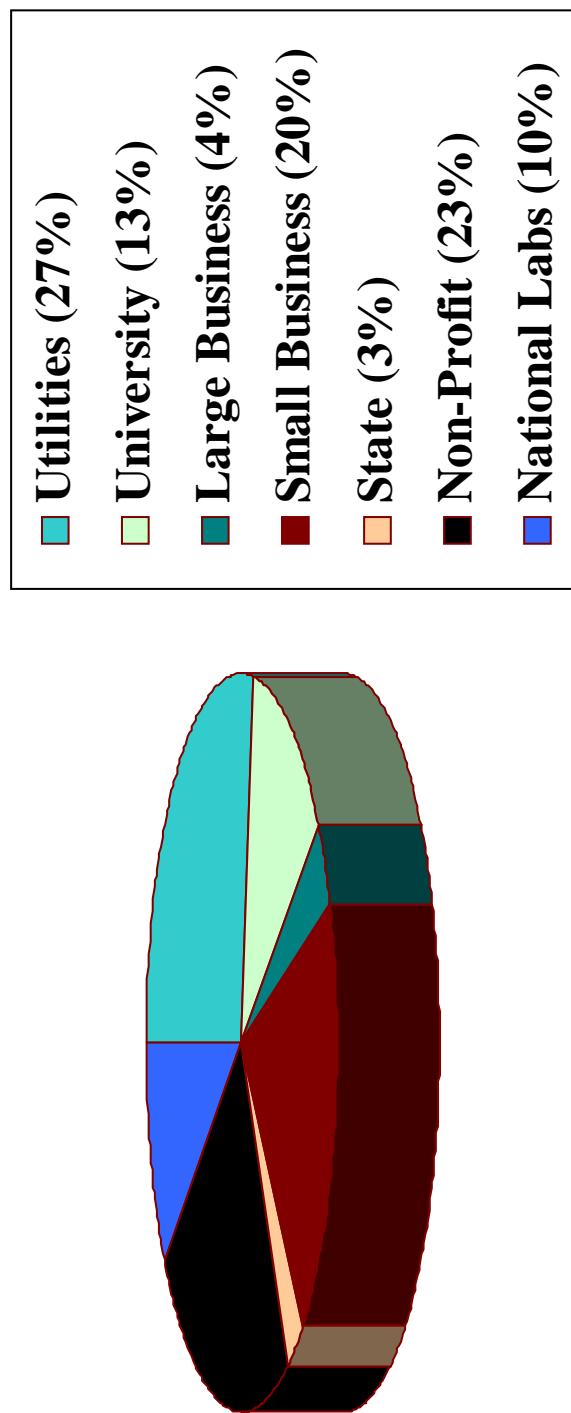


Characteristics Unique to California

- ◆ Population shifts to hotter, inland areas
- ◆ California building, appliance, and emissions practices and standards are tied to our R&D activities
- ◆ Water quality/quantity issues
- ◆ Climate characteristics
- ◆ Nature of emissions offsets, NO_x allowances
- ◆ Seismic vulnerability
- ◆ Concerns over electricity restructuring increases “the uncertainty bandwidth”



PIER RESEARCH PARTNERS





Six PIER Subject Areas

- ◆ Renewable energy
- ◆ Environmentally-preferred advanced generation
- ◆ Residential and commercial buildings end-use energy efficiency
- ◆ Agricultural and industrial demand side technologies
- ◆ Energy-related environmental research and assessment
- ◆ Energy Systems Integration



PIER Projects Related to Major Topics Funding (in millions 9/02)

Supply Renewables, EPAG	\$101
Demand Buildings, Ind/Ag/Water	\$61
System / Environment Strategic, Environmental	\$56

Currently, \$167M in open contracts, \$30M pending



The CEC/PIER Program: Two Redwoods and an Oak



Environment

DER

Efficiency

CALIFORNIA ENERGY COMMISSION



Some Areas We Will be Developing in the Near-Term

- ◆ **Efficiency**
 - Zero-energy housing
 - AWWARF collaboration
 - Electronics/Food-Ag IOF
 - CA optimized AC
 - Lighting
 - Indoor air quality
- ◆ **Environment/Climate**
 - Regional climate studies
 - Zero-emission generators
 - Environmental evaluation and mitigation
- ◆ **Distributed Energy Resources**
 - Combined heat and power
 - Solid oxide fuel cells
 - Communications, Control, Information system
 - Interconnection standards
 - Storage technology
- ◆ **Cross-Cutting**
 - Multi-state, Federal collaboration on DER testing standards



Goal for Technical Review: **How Do We Make the Program Better?**

- ♦ Comments on the past - lessons learned (or should have learned)
- ♦ Advice on modifications to current portfolio
- ♦ Insight and expert opinion on future directions
- ♦ Comments appreciated on:
 - integration with the rest of PIER
 - integration with the rest of the CEC
 - role of R&D in a state government
 - internal state process
 - integration with other energy R&D programs



General Comments for the Future: How We Will Use Your Recommendations

- ♦ PIER has to be extended to 12/31/11
- ♦ Investment plan signed into law on 9/12/02, Good to 12/31/06 - without ‘urgency’. Thus,
- ♦ Available funds (from 1/1/02) are on hold until 1/1/03
- ♦ We will implement your advice in allocating ~ \$150M for projects over the next two fiscal years



Energy Systems Integration Research Program Overview

Technical Review

November 21-22, 2002

Laurie ten Hope, Program Lead
Energy Systems Integration Research Program
Public Interest Energy Research Program
California Energy Commission

ESI Team



- Laurie ten Hope, Team Lead
- Philip Misemer, Supervisor
- Mark Rawson
- Linda Kelly
- David Chambers
- Jamie Patterson
- David Michel
- Ron Hofmann
- Don Kondoleon

Agenda

- Introductions 8:30-8:45
- PIER Overview 8:45-9:15
- Agenda/Binder Overview 9:15-9:20
- ESI Vision & Issues 9:20-9:30
- ESI Portfolio Overview 9:30-10:00
- Break 10:00-10:15
- Distributed Energy Resources 10:15-12:15
- Working Lunch 12:15-1:00
- Demand Response 1:00-2:30
- Break 2:30-2:45
- Transmission 2:45-4:15
- Strategic Systems 4:15-4:45
- Wrap-Up 4:45-5:00

ESI Vision & Mission



- ESI's Vision
 - A fully optimized electricity system

- ESI's Mission
 - Develop integrated infrastructure where electricity transactions are more effective, efficient and reliable

ESI Portfolio Overview



- Presentation will highlight
 - Current focus areas
 - How we arrived here
 - Implementation strategy & progress
 - Lessons learned & challenges

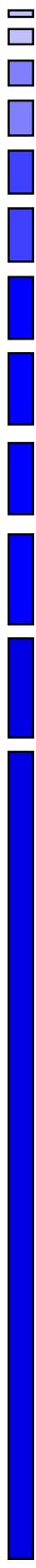
Current Focus Areas



- Effectively integrate **Distributed Energy Resources (DER)** into system
- Optimize **Demand Response (DR)** to dynamic prices and system contingencies
- Improve **Transmission** system reliability and efficiency
- Develop **Strategic Systems and Enabling Technologies**



DER Issues Addressed



- Can a substantial amount of DER be interconnected in both radial and networked distribution systems?
- Would a high penetration of DER have adverse or beneficial impact on grid?
- Determine rules and develop communication and control technologies that allow DER to access robust markets or be exposed to price signals that maximize benefits to customers and power system

DR Issues Addressed



- Develop technology and analysis to enable demand response to dynamic prices and system contingencies



Transmission Issues Addressed

- Develop advanced technologies, including software optimization tools, needed to improve reliability, operability and efficiency of transmission grid
 - Improve ability of system to efficiently match supply and demand in real time, while taking into account planned and unexpected outages
 - Improve ability of system to handle disturbances in a way that minimizes interruptions of power

Strategic Systems & Enabling Technology

Issues Addressed

- Develop long term, crosscutting and innovative advancements in science and technology
 - Reduce Seismic Vulnerability
 - Market Analysis
 - Storage Advancements
 - Communication & Control Technologies
 - Regional Solutions



How Did We Arrive Here?



- Phase 1: Lots of Projects; No Priorities
- Phase 2: Define Focus Areas
- Phase 3: Develop Research Agendas

Phase 1- Lots of Projects

Managed plethora of projects with 2 core and 2.5 matrix PY

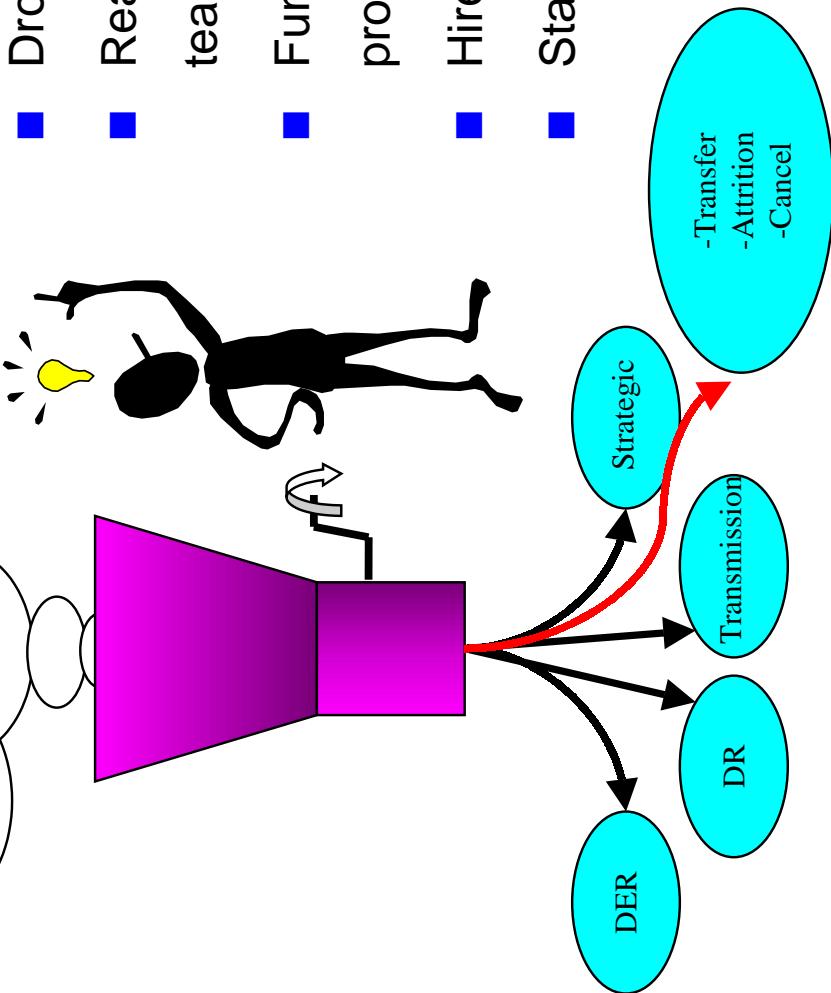
- Electric System Reliability Enhancements w/ CERTS/LBNL
- Phaser Measurement Units w/ SCE
- USAT Mod-2w/ SCE
- Energy Source Stabilizer w/ SCE
- Substation reliability w/ SCE
- Dynamic Line Rating w/ SDG&E & The Valley Group
- Distributed Resources Demo. w/ SDG&E
- Systems Stability & Reliability through Flexible A/C Transmission w/ SDG&E
- Sagging Line Mitigator (SLIM) w/ Material Integrity Solutions
- Dynamic Line Rating w/ Engineering Data Management
- Development of Composite Reinforced Aluminum Conductor w/ W. Brandt Goldsworthy & Associates
- Intelligent Software Agents for Control & Scheduling of DG w/ AESC
- Interconnection Requirements for DER w/ Onsite Sycom (Focus 1&2)
- University of California Center for Study of Electricity Markets,
- PG&E – Electric System Seismic Safety and Reliability– Phase 1 & 2
- 2 kWh Energy Storage Flywheel w/ Trinity Flywheel
- Secondary Distribution Impacts of Residential EV Charging w/ Georgia Tech, NEETRAC
- Light-Activated Surge Protection Thyristor for Distribution System Reliability w/ Opti-Switch Technology
- EPRI (e.g. – DER, Grid Support & Operations, Jefferson Project, Airport Solutions, PV Toxics, Data Warehousing, Dynamic Construction Cycle, Linked Infrastructure Security)
- GTI (DER)

Phase 2 - Define Focus Areas & Hire

\$26 million in 20 contracts; 17 EPRI targets; 12 TC's; GTI target; 16 unsolicited proposals; across many subjects

Organized & triaged portfolio to:

- Define priorities & policy relevance
- Drop misaligned projects
- Reassign projects to other PIER teams
- Fund a few select continuation projects
- Hire core staff
- Start new work



Phase 3 - Building a Research Agenda



Plan of Attack

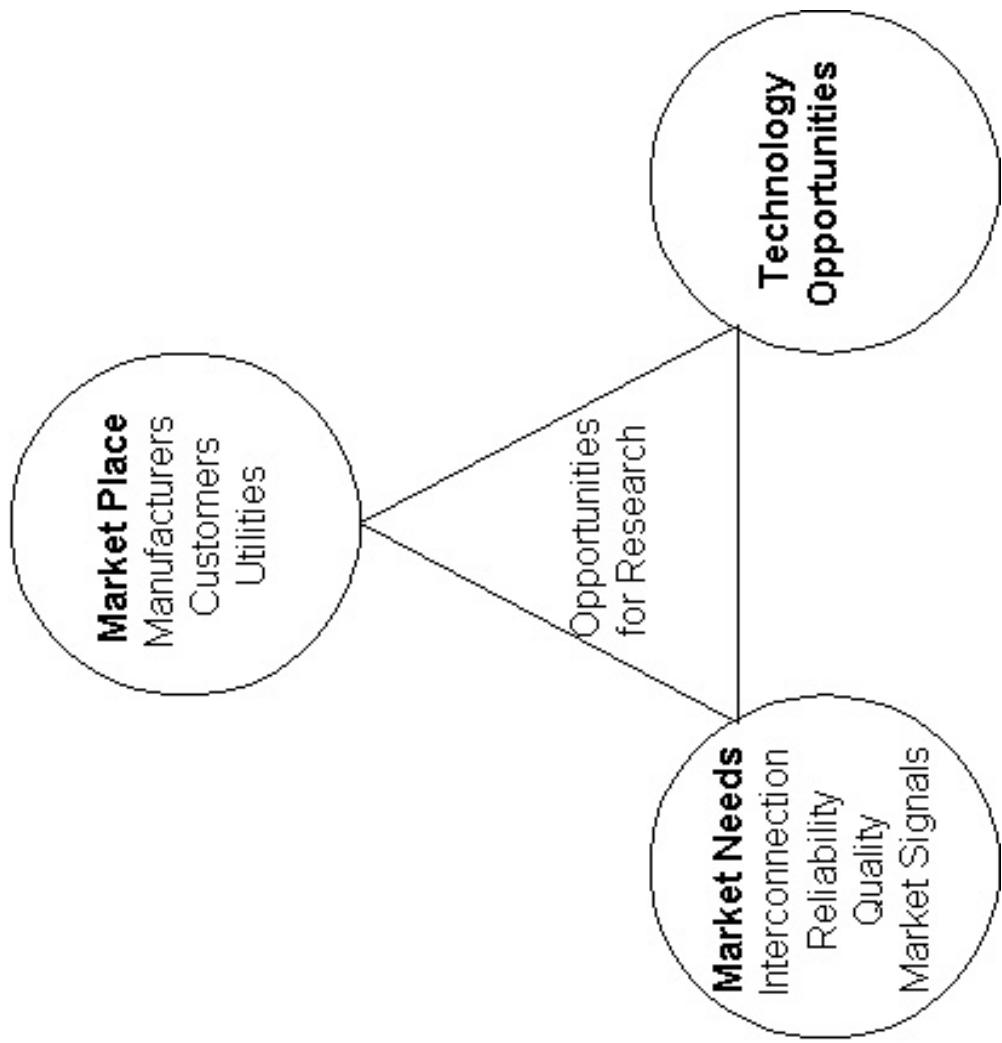
■ Short Term - “No Regrets”

- Focus on initiatives with clear public need
 - » DG interconnection for public safety
 - » DR to create functional market
 - » RT transmission management tools to prevent grid collapse

■ Longer Term - Do more homework

- Determine significant players
- Baseline technologies - what's state-of the-art?
- Identify research gaps
- Prioritize research opportunities
- Implement
- Evaluate success

Public Interest Research Opportunities?

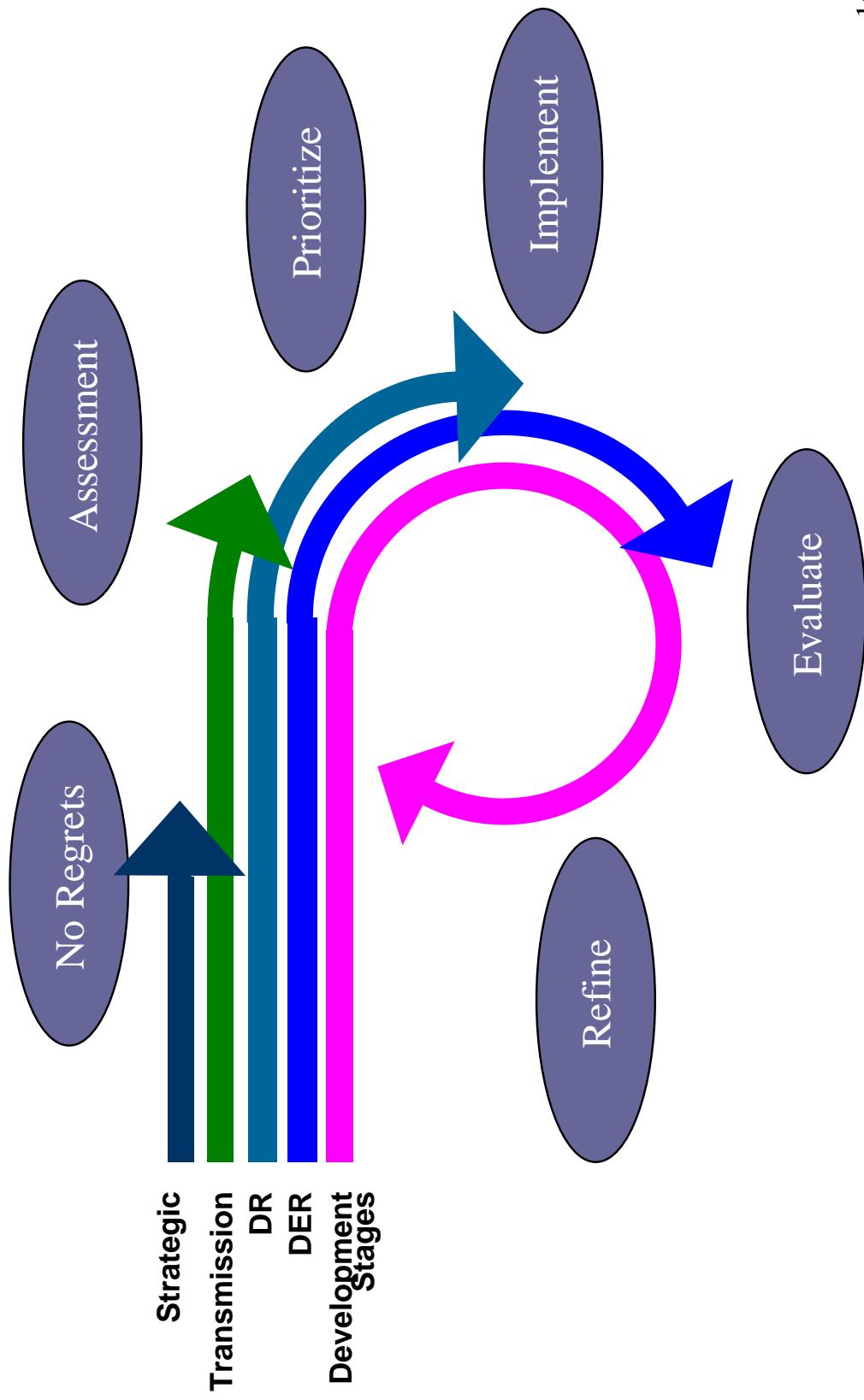


Can ESI play role to address R&D need?

Research Plan Status



All research areas are at different stages of development

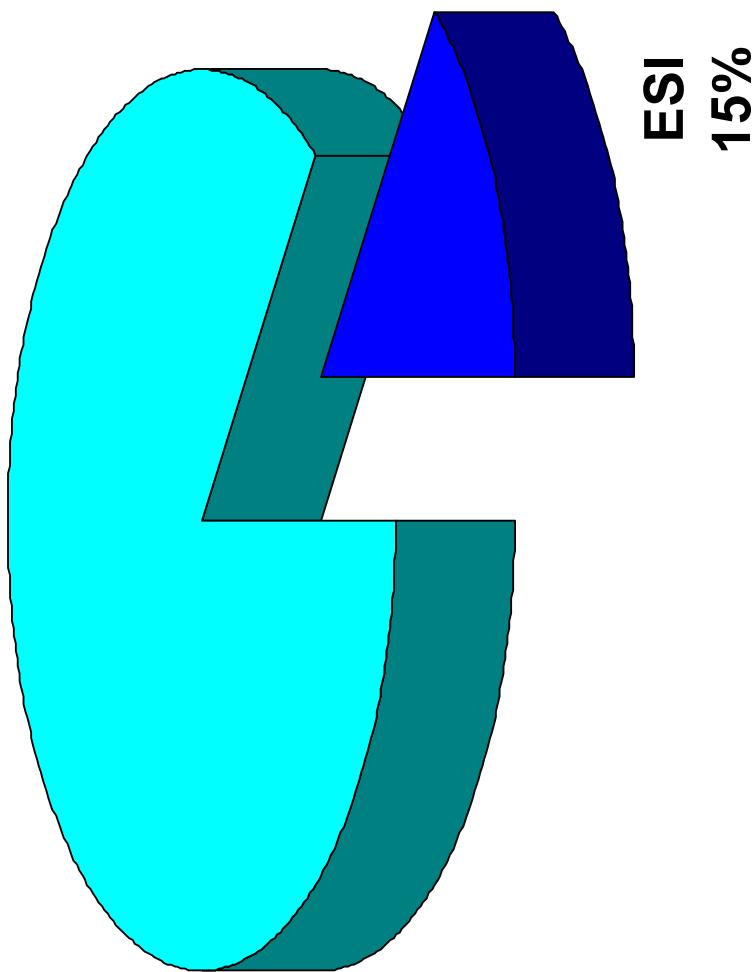




ESI's Portion of PIER Dollars

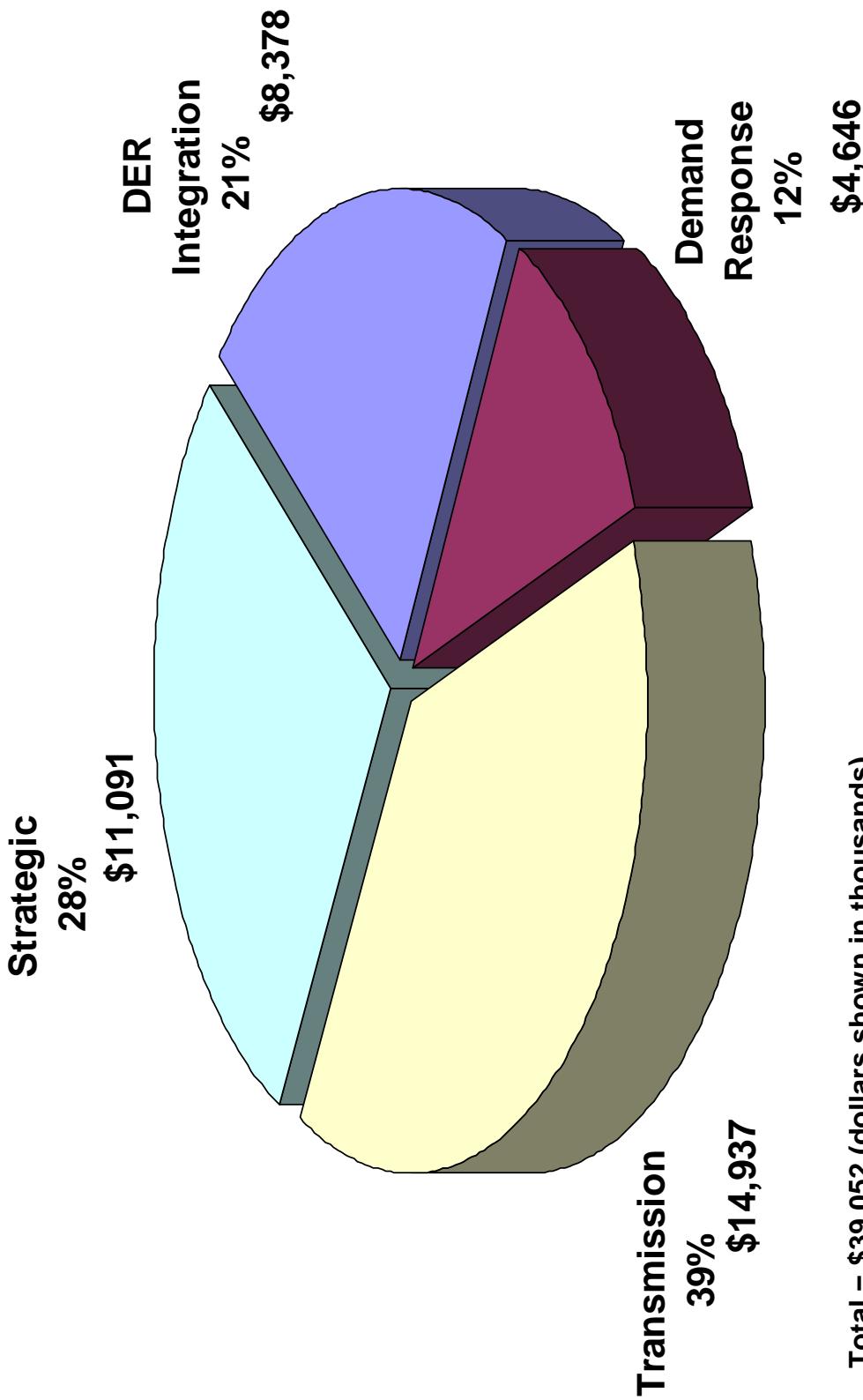


Other PIER
85%

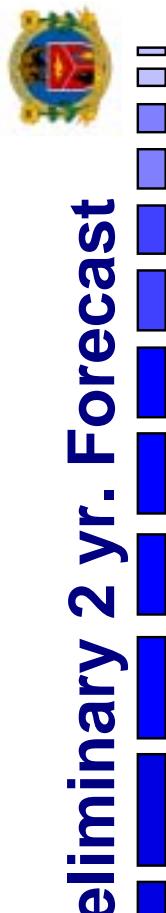




Portfolio Balance



Current Budget and Preliminary 2 yr. Forecast



Current FY '03/04 & '04/05			
DER	\$ 8.4	\$ 9.0	
DR	\$ 4.6	\$ 8.0	
Transmission	\$ 14.9	\$ 11.0	
Strategic Systems	\$ 11.1	\$ 2.0	
Total	\$ 39.0	\$ 30.0	

Dollars in millions

Lessons Learned



■ Memberships Should be Selected Carefully

- They are not always best value
- Requires active involvement to shape agenda & bring “public” perspective
- Not always possible to influence group
- Value improved when can leverage and bring other CA stakeholders into membership (e.g., EPRI seismic project)



Lessons Learned Cont'd



- Strategic Relationships are Critical
 - Examples include DOE, CERTS, industry
 - Leverages value; share results
 - Avoid duplication
 - Can help make connection to market
- Program Implementation Needs to be More Programmatic
 - With limited resources, can't manage many individual projects
 - May lose participation of small inventors

ESI Challenges



■ Limited Resources:

- PIER will initiate \$150 million in new projects in next 24 months (\$22-30 million for ESI)
 - Limited staff
 - Need diverse disciplines & technology breadth

■ Accountability:

- Be responsible stewards of public money
 - Foster good research; cancel others
 - Get research connected to market

Questions



■ For Committee to Think about Throughout the Day...

- Are we focused enough on *highest* priorities?
Are we spread too thin? Should we “triage” further?
- Are we missing major opportunities?
- Are we positioned to address our challenges?
- Are we selecting the right projects, right collaborators and right researchers?





Distributed Energy Resources Integration Research Program

Technical Review
November 21, 2002

Mark Rawson, Program Manager
Energy Systems Integration Research Program
Public Interest Energy Research Program
California Energy Commission



Presentation Topics

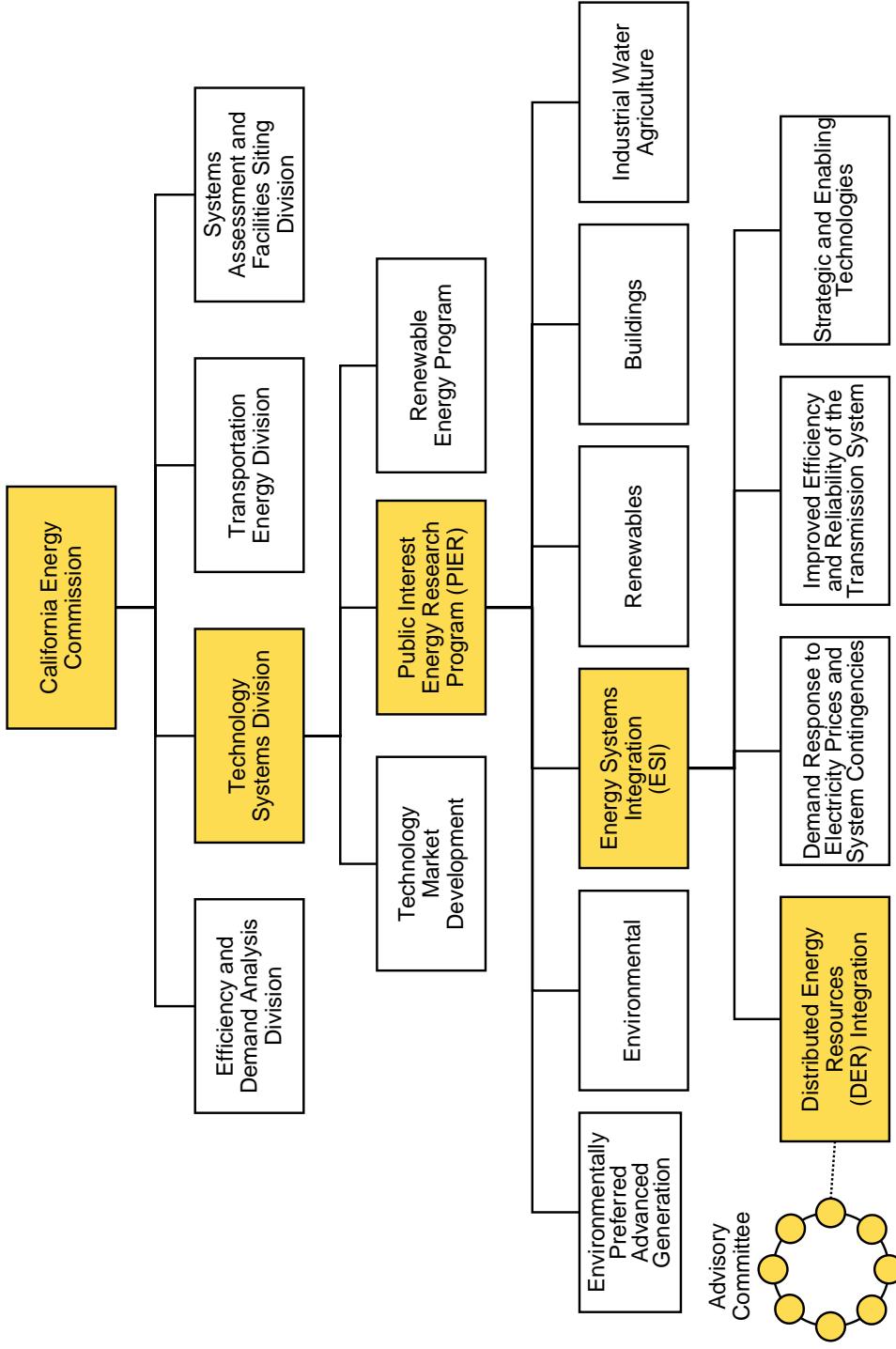
- Introduction
- Context & Program Focus
- Current Program
- Planning Activities
- Roadmap to Future & Collaboration
- Panel Discussion

Note: Panel members are encouraged to ask questions and make comments anytime.

ESI DER Integration



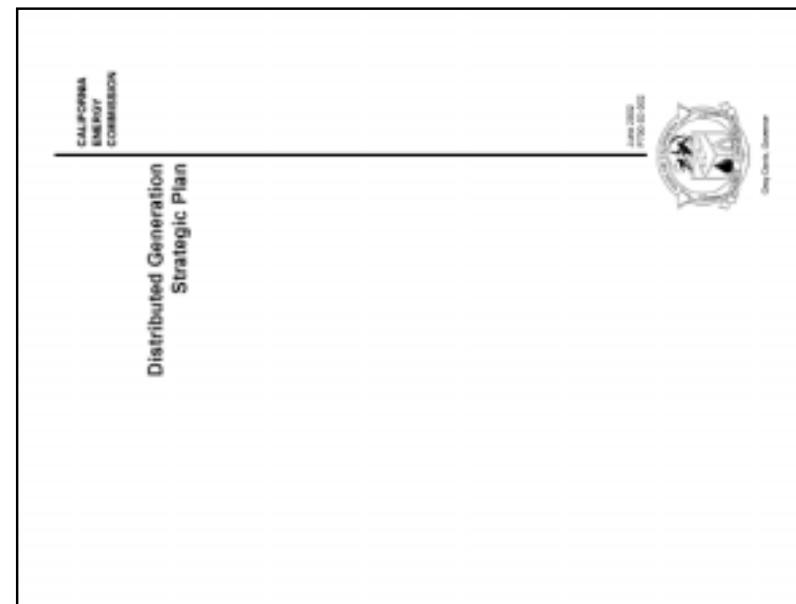
DER Integration part of Energy System Integration R&D Program



CEC Strategic Plan



- CEC recently completed DG Strategic Plan which formalizes policy, vision, mission and goals of all CEC DER activities
 - PIER DER R&D is aligned with plan



CEC Strategic Plan Vision & Mission



Implementation of the Plan is two-fold

- Remove barriers that restrict DER deployment (e.g., Rule 21) for end users that choose DER
- Learn about grid and environmental benefits of DER and then foster them

Vision	Mission
Distributed Generation will be an integral part of the California energy system, providing consumers and energy providers with safe, affordable, clean, reliable, and readily accessible energy services.	Energy Commission shall lead a statewide effort, which promotes and deploys distributed generation technologies to the extent that such effort benefits energy consumers, the energy system, and the environment in California.

CEC Strategic Plan Goals



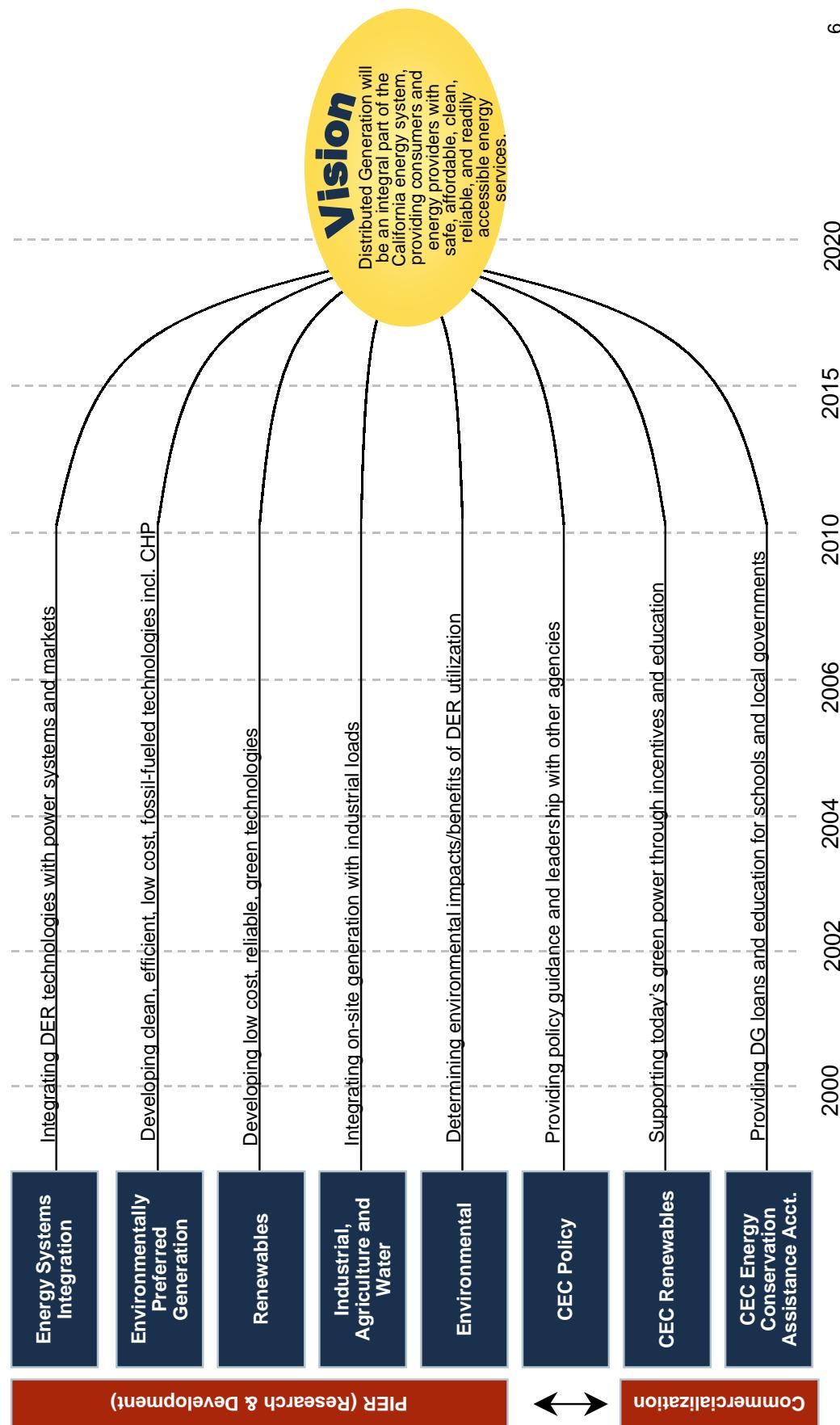
Strategic Plan outlines near-term, mid-term and long-term goals to achieve the Vision

	<i>Near-term Goals (3-5 years)</i>	<i>Mid-term Goals (5-10 years)</i>	<i>Long-term Goals (>10 years)</i>
	<ul style="list-style-type: none"> • Establish a DG State Agency Coordination Group to cooperatively address DG issues and ensure consistent handling of these issues throughout state government. • Raise consumer awareness about distributed generation by creating and maintaining a central repository of DG general information. • Develop and conduct targeted consumer education campaigns. • Fund research, development and demonstration programs to advance the development and deployment of DG technologies • Assess the market, technological and regional potential for DG to determine a reasonable goal regarding electric generation capacity from DG by 2020. • Identify and address institutional and regulatory barriers, which are interfering with the purchasing, installation, and operation of DG facilities. 	<ul style="list-style-type: none"> • Reduce DG equipment costs to a level that would obviate the need to provide government incentives to deploy DG. • Enhance the emissions and efficiency profiles of DG technologies, monitoring and modeling techniques, and cost-effective control technologies such that the resulting environmental impacts, public exposure, and permitting support wide-scale deployment. • Establish markets that pay for the full value of DG, including grid benefits, environmental benefits, greenhouse gas reduction credits, energy conservation, and waste reduction benefits. • Certify and deploy DG systems in such a way that procuring DG is as routine, as purchasing appliances for the home. 	<ul style="list-style-type: none"> • Make California's energy generation and delivery system the cleanest and most efficient, reliable, and affordable in the nation by maximizing appropriate use of DG. • By 2020, ____ percent of all incremental generation will be DG (see Near-term Goal #5).

CEC DER Roadmap



Efforts across CEC are moving California to the Vision



DER Technology and Policy Issues



Numerous issues were identified as part of Strategic Plan development

	DER Issues
A. Environmental Impact	<ul style="list-style-type: none"> • When will DER technologies have a positive impact on the environment? • Should clean DER technologies be subsidized or otherwise encouraged? • Should DER be used to improve air quality? • Should DER improve worker health and safety?
B. Low Cost Power	<ul style="list-style-type: none"> • Can DER be competitive with central power generation? • Should customers have the choice of DER to reduce power cost? • Is DER the most economically efficient approach to generating and delivering power to customers?
C. Generation Reliability	<ul style="list-style-type: none"> • Will DER improve customer power reliability? • Can customers use DER for high reliability and power quality needs?
D. Grid Effects	<ul style="list-style-type: none"> • Will DER improve grid reliability? • Will DER have a positive or negative effect on the power system? • Can grid effects be monitored and allocated to stakeholders? • How can the locational value of DER be exploited? • How can you measure and reward consumers for the grid benefits they generate through use of DER?
E. Interconnection	<ul style="list-style-type: none"> • Should technical requirements, processes and contracts be modified for DER? • Can DER be safely and cost effectively interconnected with the power system? • Is plug and play possible for DER interconnection?
F. Siting & Permitting	<ul style="list-style-type: none"> • Should siting and permitting requirements be modified for DER?
G. Integration	<ul style="list-style-type: none"> • How can DER be integrated with California's current system operations? • How can the system be operated to optimize DER?
H. Market Structure	<ul style="list-style-type: none"> • How can DER be integrated with California's current market structure? • Can the market structure be changed to create a win-win for all stakeholders? • How can utilities be incentivized to participate and/or encourage DER? • Can a market structure be created that will allow DER to compete? • Should California use net metering?

Note: Issue candidates are not listed in any particular order



PIER DER Portfolio



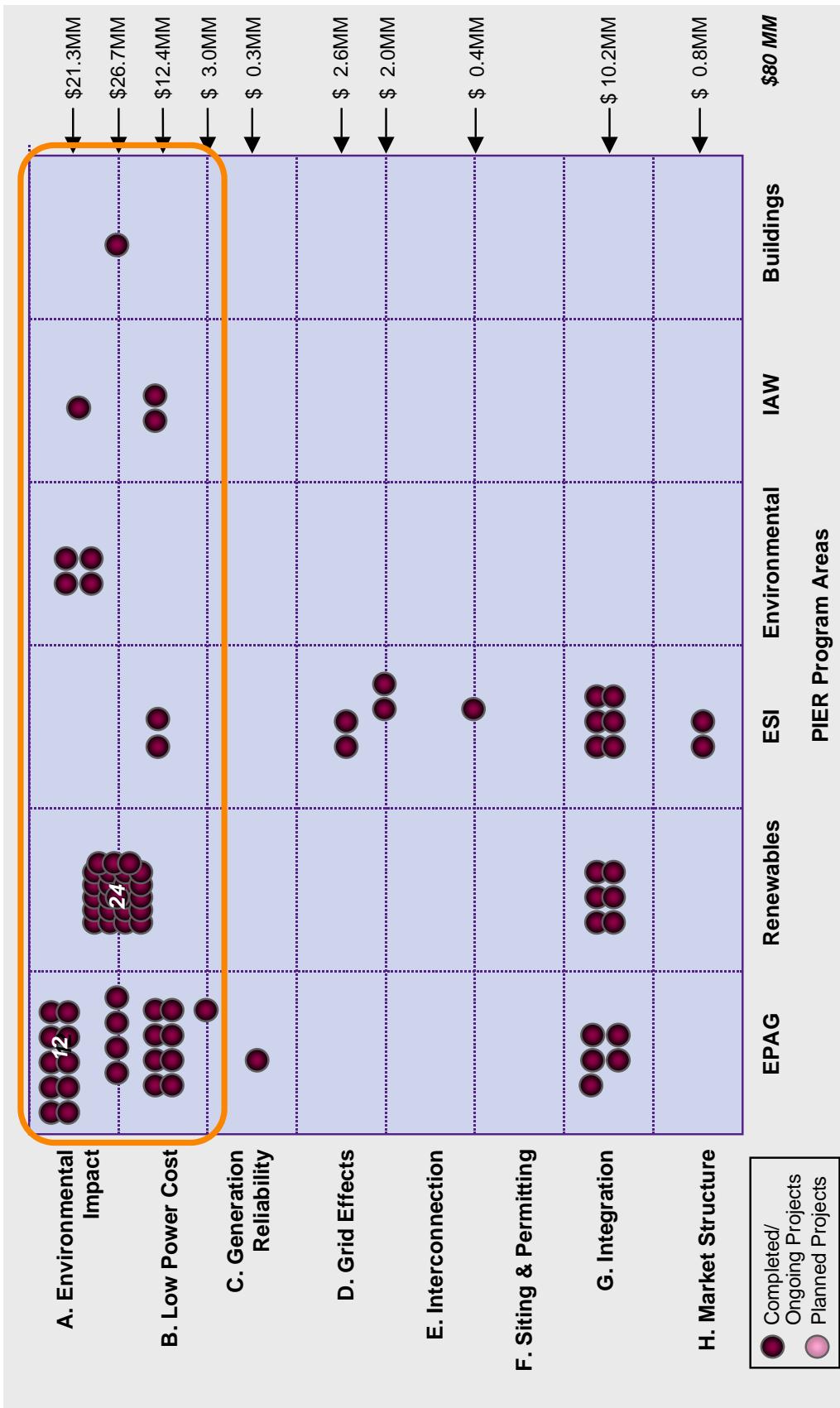
DER major PIER focus

- 84 projects totaling \$80M out of over \$255M in total PIER are DER related (projects under the small grant program are excluded)
- All six PIER program areas have projects that are DER related
- Research projects address all DER issues areas identified during Strategic Plan process





80% of PIER DER portfolio focused on reducing environmental impact and developing lower cost power



ESI DER Program Focus



ESI DER Integration program is focused on funding systems-level research and enabling RD&D in areas of interconnection, grid effects and market integration

- Near-Term Research Objectives (<5 years)
 - Enable safe interconnection to grid
 - Determine limits of DER penetration into grid
 - Quantify and demonstrate grid benefits
 - Demonstrate novel approach of microgrids
- Mid-Term Research Objectives (5-10 years)
 - Optimize benefits/impacts of DER
 - Determine and enable market mechanisms to capture and monetize DER benefits



Key Issues



Determined key research issues and developed initiatives in three focus areas to address overarching question

Are there research, development, demonstration or commercialization opportunities that will make DER a significant resource in California's power system?

Interconnection

Can a substantial amount of DER be interconnected in both radial and networked distribution systems?

Grid Effects

Would a high penetration of DER have adverse impacts and/or positive effects on the T&D system?

Market Integration

Can DER access robust markets or be exposed to price signals that will maximize benefits to customers and the power system?



Presentation Topics

- Introduction
- Program Focus & Context
 - Current Program
 - Planning Activities
- Roadmap to Future & Collaboration
- Panel Discussion

Note: Panel members are encouraged to ask questions and make comments anytime.

Current ESI DER Program Current Projects



Promising research already in pipeline. At present, portfolio includes 10 projects with total budget requirement over \$6 million for life of projects

- Alternative Energy Systems Consulting (AESC)
 - Advanced Communication & Control Technology
 - \$550k
- Consortium for Electric Reliability Technology Solutions (CERTs)
 - Microgrid Concept Development
 - Standard Power Electronic Interface
 - Microgrid Lab Testing Preparation
 - \$1.5M
- Forging a Consensus on Interconnection Requirements in California (FOCUS)
 - Rule 21 Technical Support
 - Interconnection Monitoring Program
 - Interconnection Guidebook
 - IEEE 1547/Rule 21 Coordination
 - \$1.5M
- Distributed Utility Integration Test (DUIT)
 - Laboratory demonstration and testing of varying levels of DER in distribution systems
 - \$2.0M
- Regional Solutions Pilot - New Power Technologies
 - Developing integrated T&D modeling tools to assess locational benefits of real & reactive power insertions into a T&D system
 - \$616k

Current ESI DER Program Metrics



At present, three special metrics being applied to projects

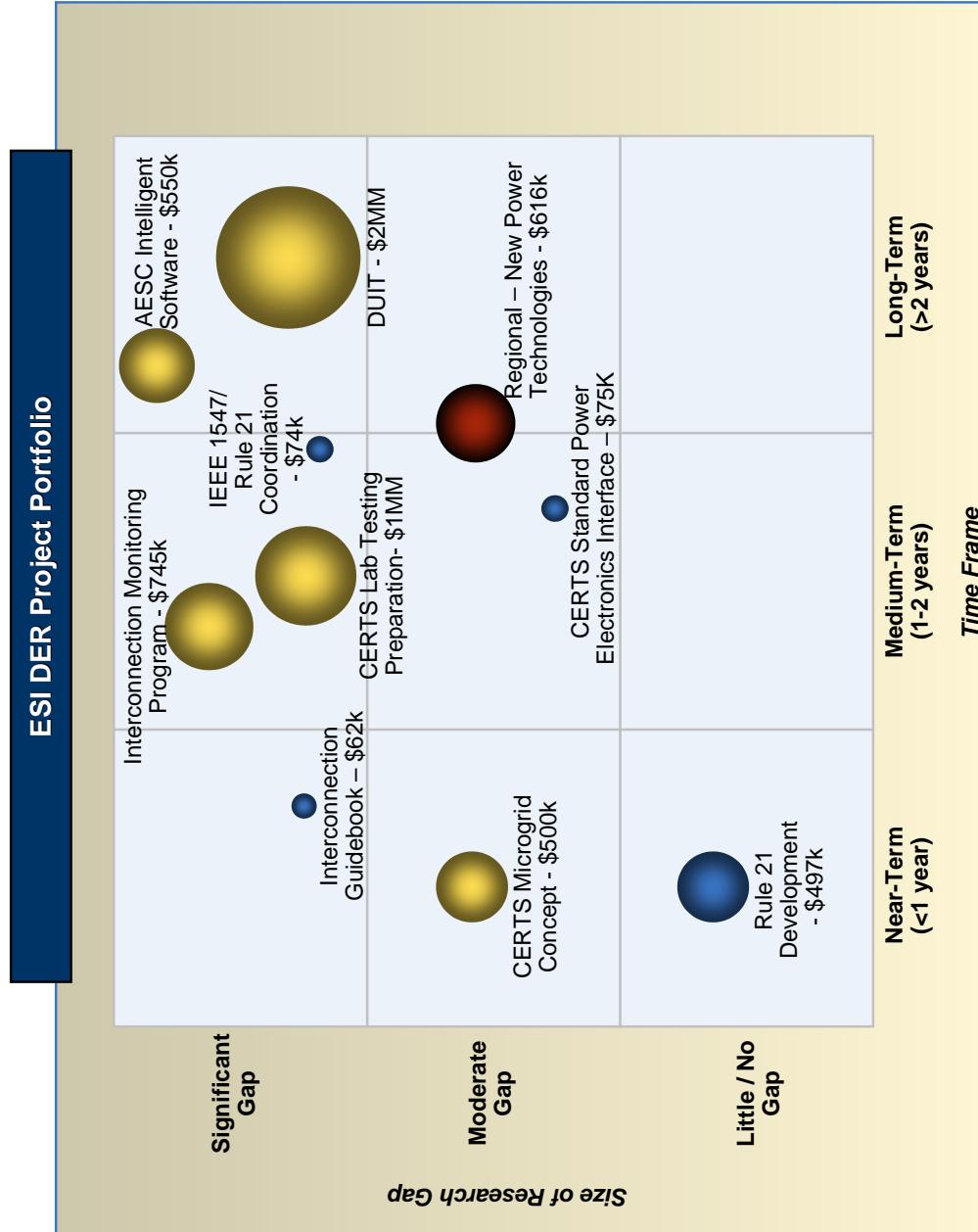
- Gap Size: level to which there is an unfulfilled research need that project is potentially filling
- Implementation Risk: likelihood that activities may not yield expected/desired results
- Level of Technology Development: level of sophistication of underlying technology and its potential impact



Current ESI DER Program Current Portfolio - View /



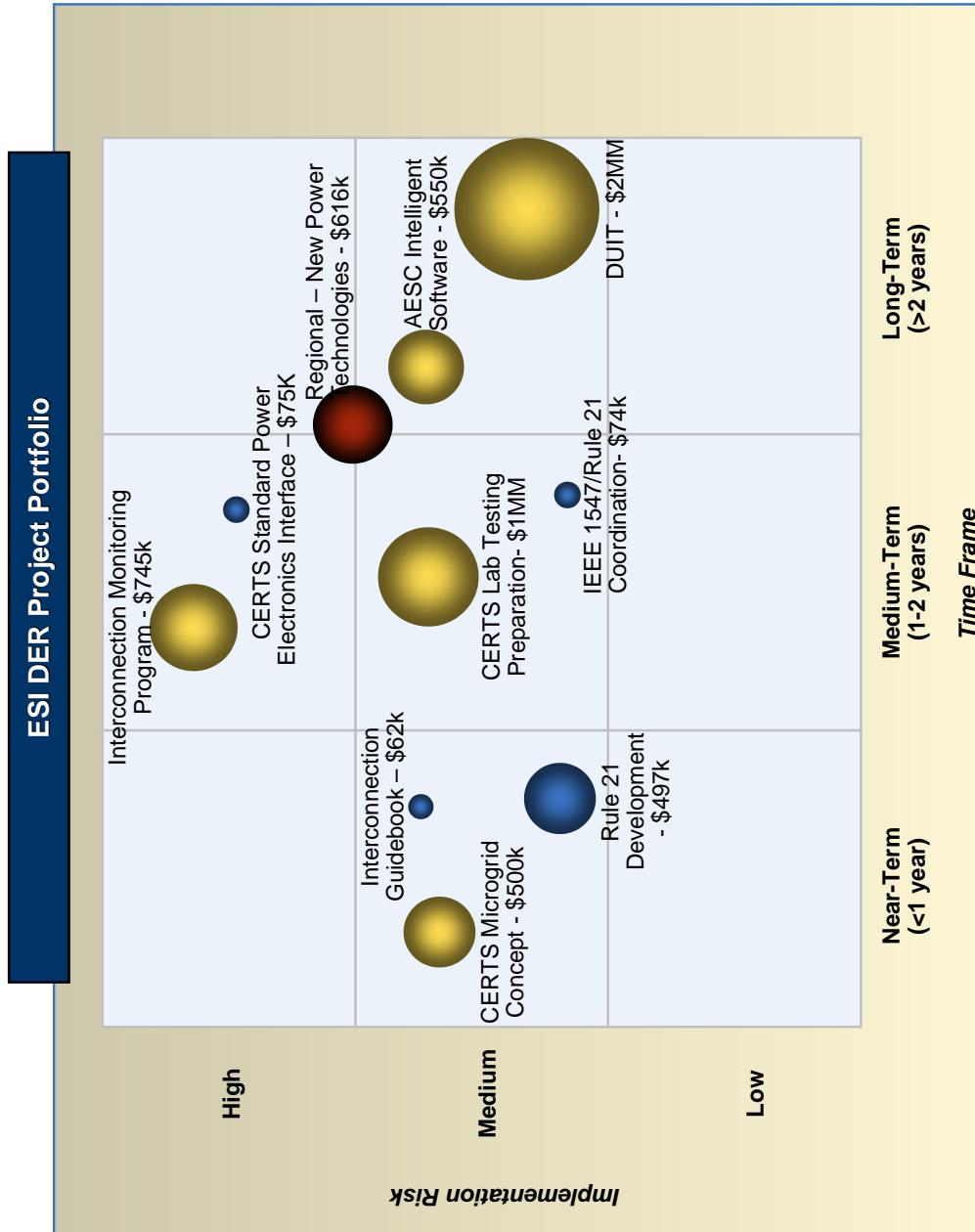
Portfolio is addressing significant gaps with large (>\$500k) projects that have medium to long-term time frames



Current ESI DER Program Current Portfolio - View II



The portfolio is taking a medium implementation risk overall

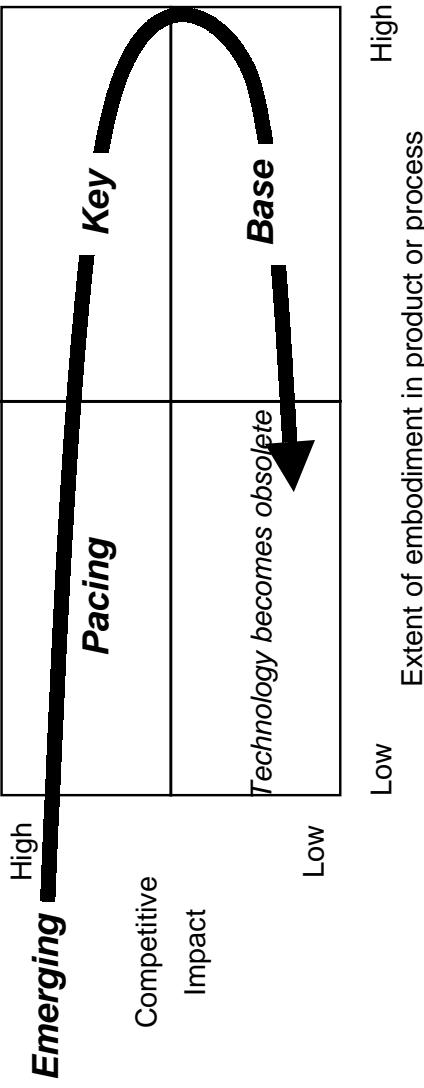




Technologies follow a competitive pathway that changes as technology matures

- **Base:** Although essential to business, these technologies cannot provide significant competitive advantage
- **Key:** These technologies are critical for today's bases of competition
- **Pacing:** Although they are not fully embodied in current products, they may, if successfully applied, have a substantial impact on basis of competition in reasonably near future
- **Emerging:** These technologies may have an impact on competition in future but this is far from certain

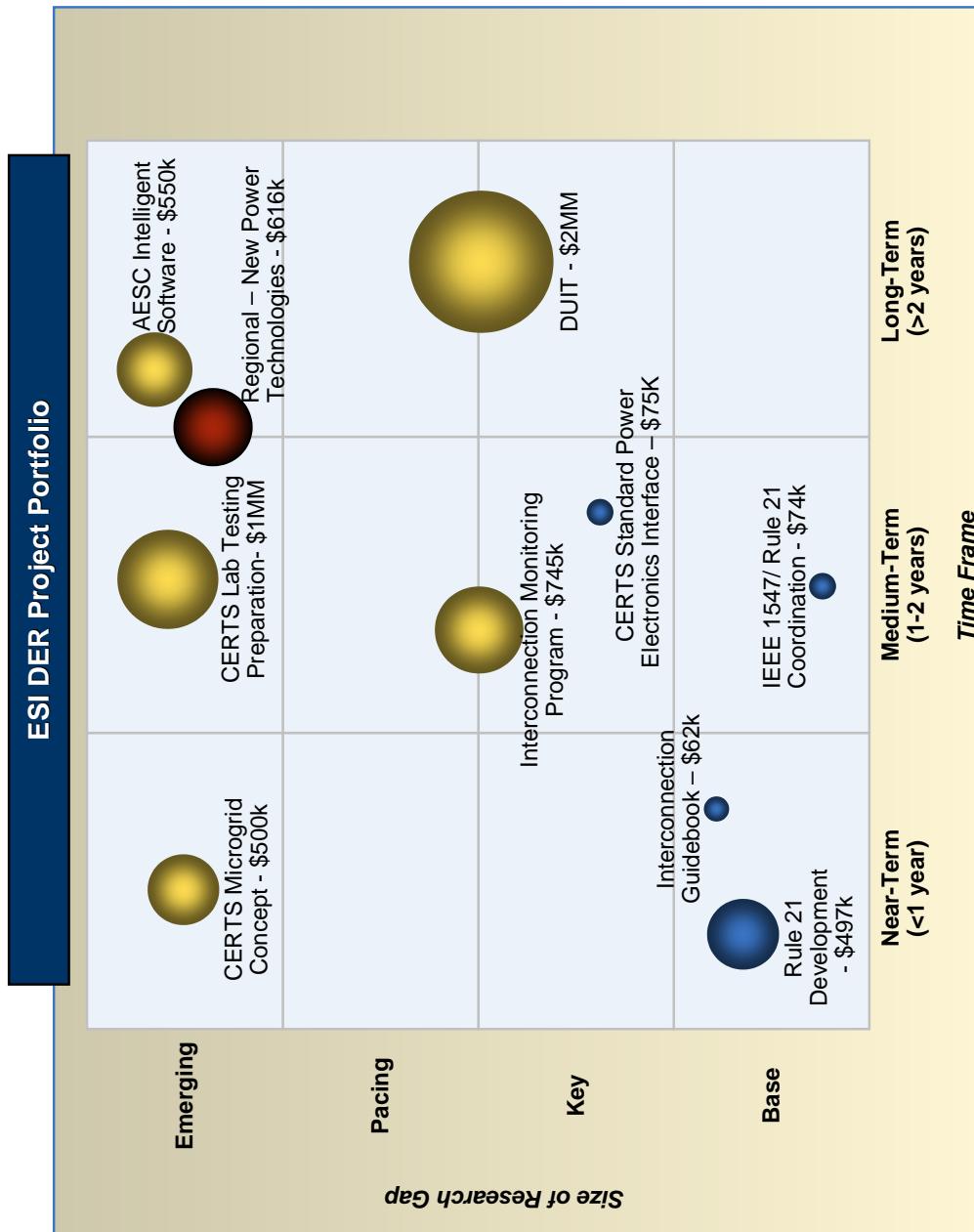
The path followed by new technologies



Current ESI DER Program Current Portfolio - View III



Low budget projects appear to focus around key and base technologies





The Times

First Microturbines Meet CA Grid Interconnect Standards

SACRAMENTO- In a substantial move to advance distributed generation in the state, the California Energy Commission certified the 30- and 60-kilowatt Capstone MicroTurbine energy systems to comply with Rule 21 grid interconnection standard. The move is expected to dramatically lower the costs and streamline installation...

EnergyUserNews

March 2002

Rule 21 Interconnection

- Reduces average cost of interconnection fees to consumers by up to 37%
- Resolves technical safety issues
- Establishes technology and size neutral review process
- Identifies testing and certification requirements
- Enables insertion of new generation into grid

Current ESI DER Program *Featured Projects*



Key project researchers here to provide an overview of two featured projects

- Distributed Utility Integration Test (DUIT) - Bill Erdmann
- New Power Technologies - Peter Evans





Presentation Topics

- Introduction
- Program Focus & Context
 - Current Program
 - Planning Activities
 - Roadmap to Future & Collaboration
- Panel Discussion

Note: Panel members are encouraged to ask questions and make comments anytime.



Presentation Topics

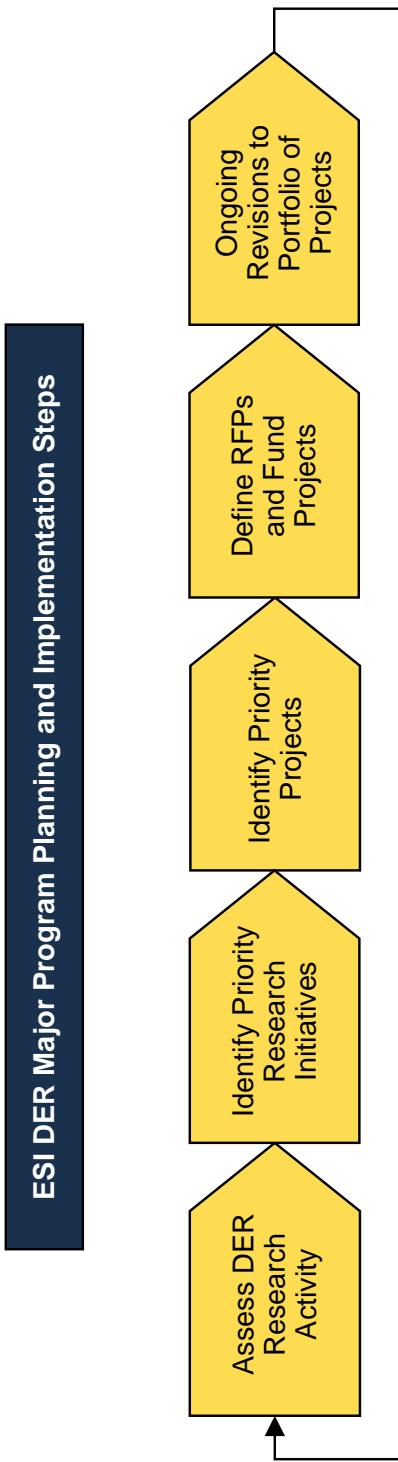
- Introduction
- Program Focus & Context
- Current Program
- Planning Activities
 - Research Assessment
 - Value Network Assessment
 - Value Metrics Tool
 - Advisory Committee
- Roadmap to Future & Collaboration
- Panel Discussion

Note: Panel members are encouraged to ask questions and make comments anytime.

DER Research Assessment



ESI assessed research activity in DER in order to make appropriate funding decisions



DER Research Assessment



Identified 31 research initiatives with significant and moderate gaps

Interconnection	
Understand impact of and adopt new interconnection requirement	2
Develop guidelines and best practices for interconnection	5
Educate stakeholders on new requirements, contracts and processes	7
Modify standardized requirements and standardized designs based on modeling, testing and field experience	6
Develop standardized products for small DER	8
Develop new technologies that would eliminate or Reduce some requirements or costs of interconnection	13

Market Integration	
Demonstrate viability of a value network through a replicable pilot program	3
Develop market mechanisms to capture and monetize additional DER benefits (e.g., T&D, reliability, environmental, CHP, etc.)	6
Launch a new market for DER that captures all value generated	7a
a. Start from scratch, develop the best market structure for DER now and in the future	
Integrate the required technologies to reduce costs of participating in markets	4
Assess the system requirements for communications, control, metering, software for billing and settlement	7b
Pilot and then launch	7c
Develop advanced control and optimization approaches and technologies	8
Develop low cost metering	10
Develop low cost communications and control	11
Develop software to optimize DER in response to market price signals	12
Develop advanced storage to optimize DER in response to market price signals	14

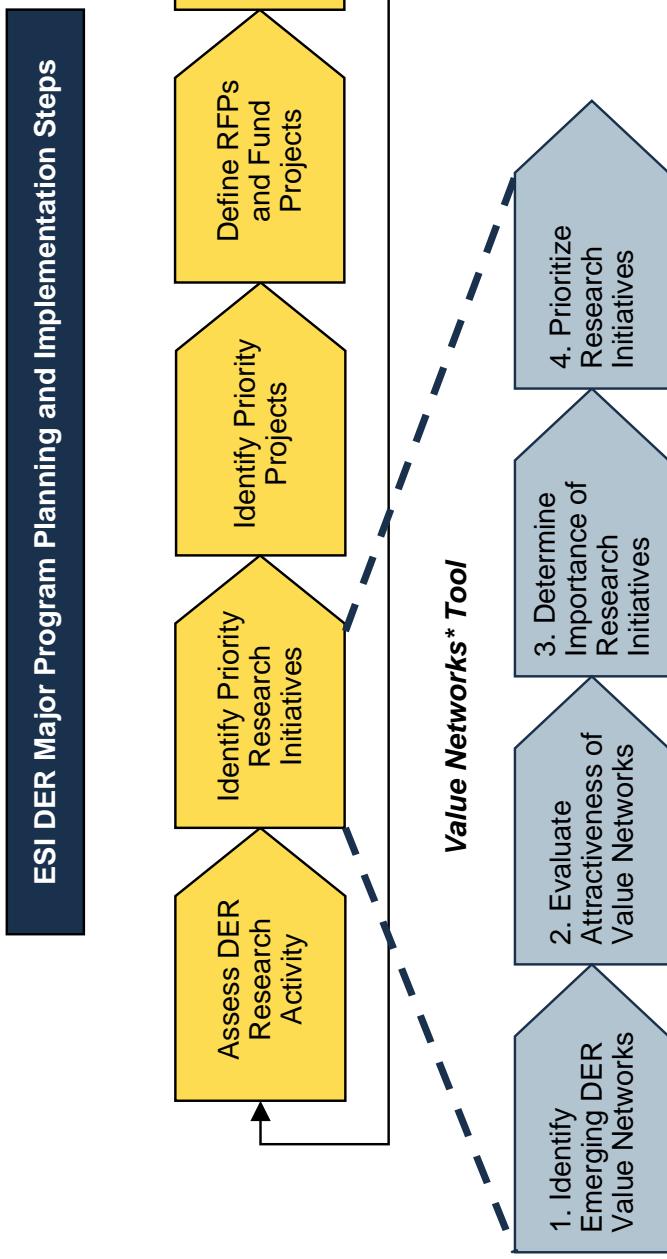
DER Technologies and Products	
Develop zero energy buildings	7
Reduce equipment and installation costs of DER technologies	1
Increase efficiency of DER technologies	2
Reduce emissions from DER technologies	3
Improve and demonstrate increased reliability of DER technologies	5
Fuel Infrastructure	
Develop a hydrogen infrastructure	16

 Significant Gap
 Moderate Gap

DER Value Networks Analysis



After uncovering DER research gaps however, needed to identify priority research initiatives because of uncertainties in DER technology, regulations and markets that make investment decision-making difficult



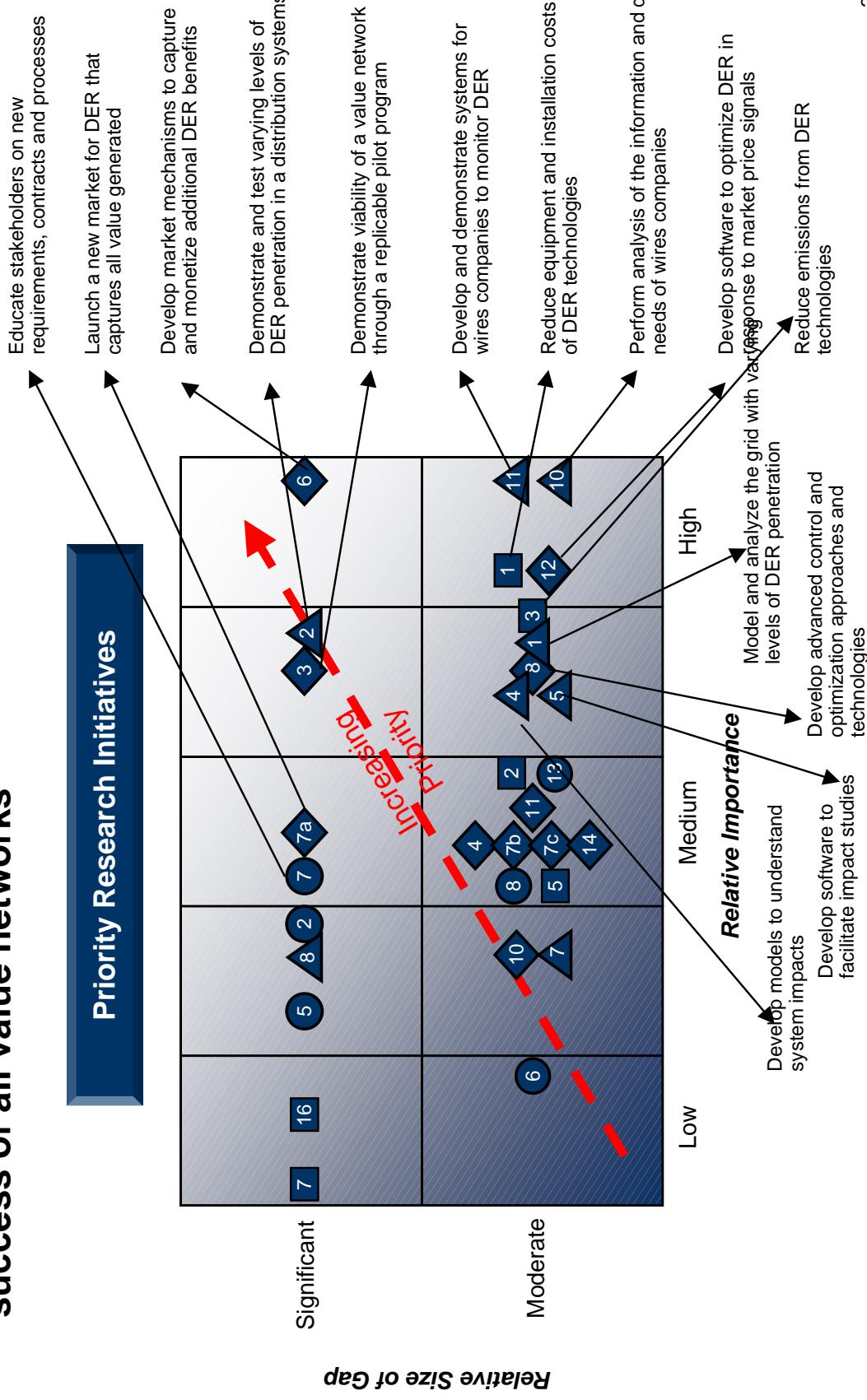
Tool identifies emerging value networks, evaluates their attractiveness, determines importance of and prioritizes research initiatives

*Value Network is story of how business models and technologies interact with one another to create, sell and deliver value to customers

DER Value Networks Analysis Results



Tool identified, in priority order, the initiatives that are most important to success of all value networks





Presentation Topics

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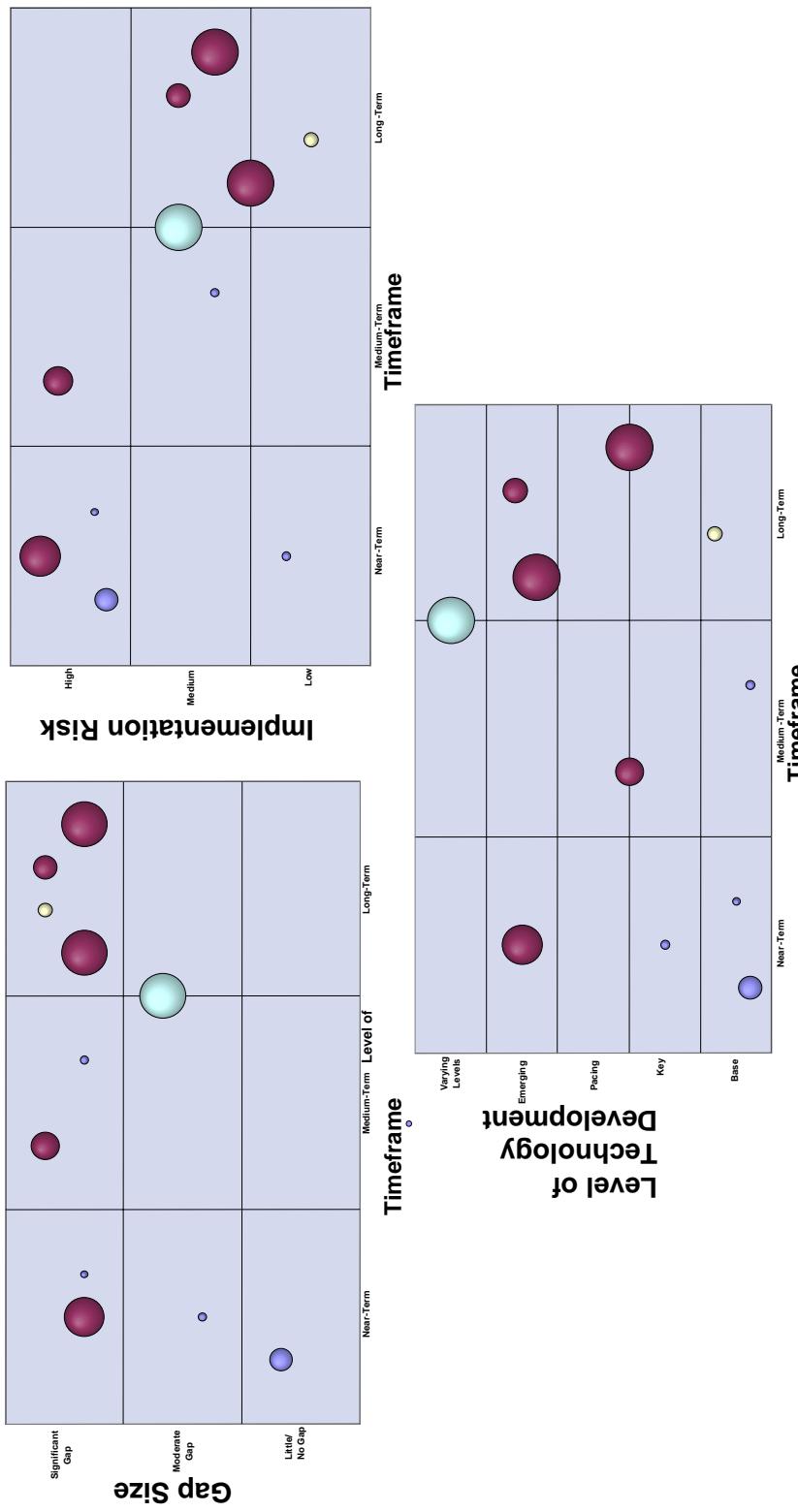
Note: Panel members are encouraged to ask questions and make comments anytime.

Why do Metrics?



ESI's DER portfolio management tools provide some important insights regarding timing, targeted research gaps, risk and stage of technology development addressed by DER projects

PIER ESI DER Projects



Why do Metrics?

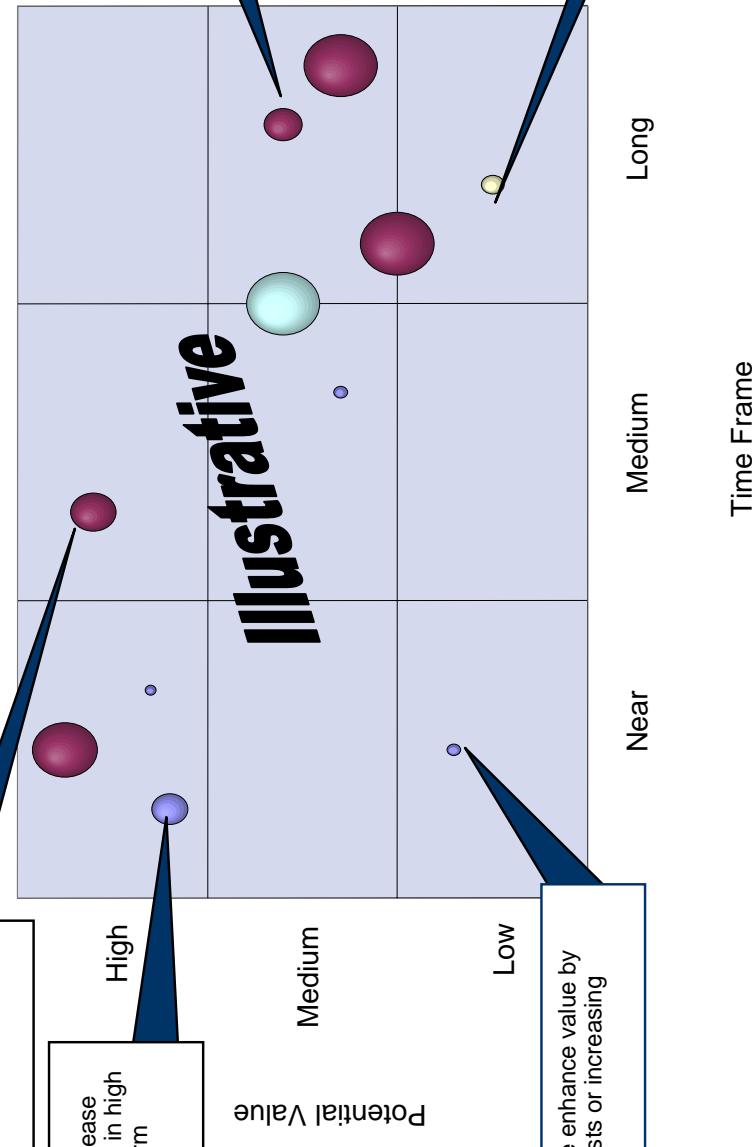


However, ESI did not have tool that estimates value of DER projects that could provide key insights into relationships between cost, potential value, risks and timing of projects

DER Portfolio Assessment

Can we accelerate high value projects?

Should we increase our investment in high value, short-term projects?



Which programs are “out of line” and what other reasons exist for their inclusion?
 • Knowledge-building
 • Insurance
 • Other?

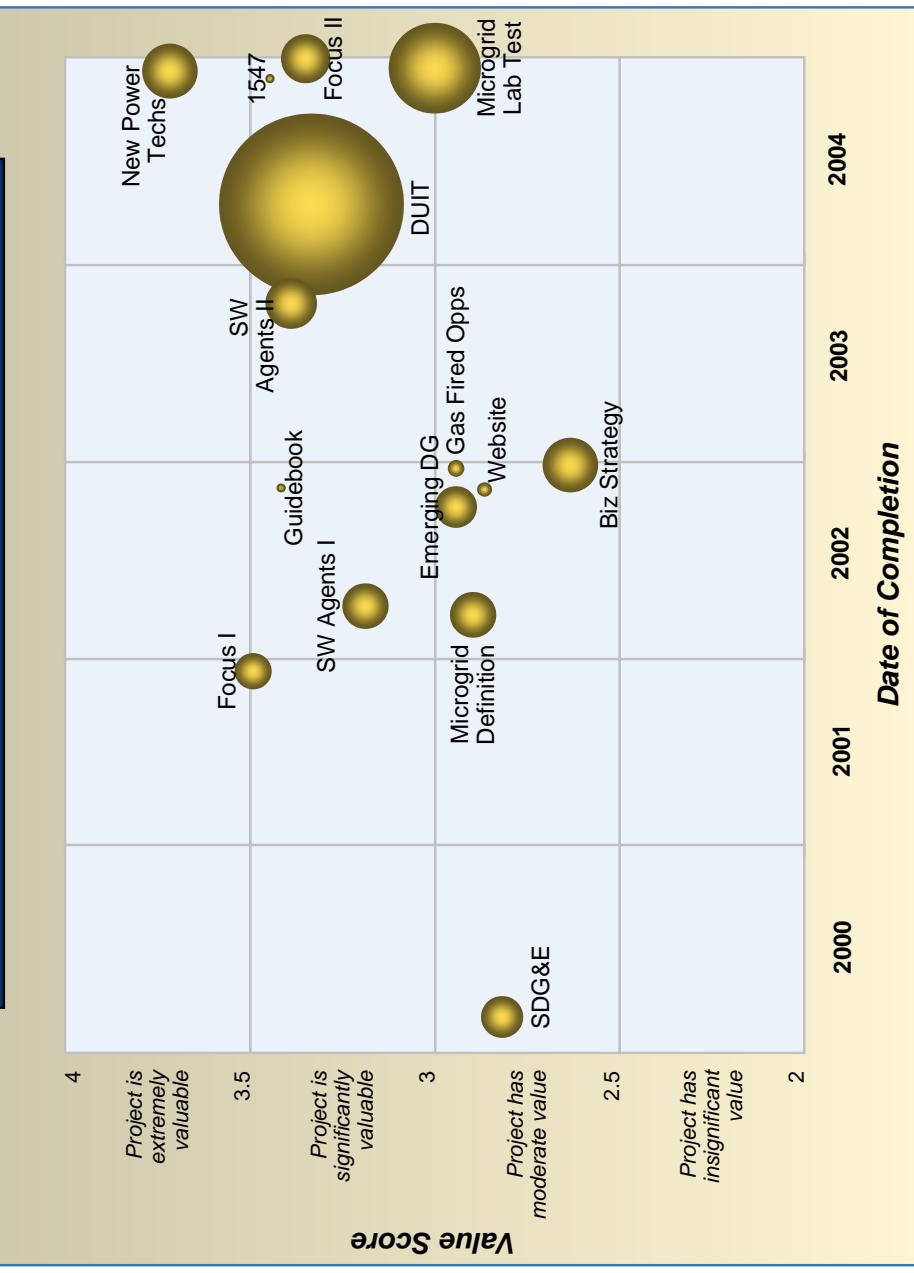
What “sensitivities” exist?
 • Technology advancement
 • New entrants
 • Customer behavior
 • Environmental

Results of Pilot Implementation Portfolio Analysis



Pilot implementation uncovered key issues for program to consider

Value Score Portfolio Analysis



- Key Issues**
- How can we increase value of these projects and portfolio?
 - Are we maximizing the “bang for buck”?
 - Are we allocating our funds efficiently?
 - Can we accelerate projects?



Presentation Topics

- Introduction
 - Program Focus & Context
 - Current Program
 - Planning Activities
 - Research Assessment
 - Value Network Assessment
 - Value Metrics Tool
 - Panel Discussion
- A red dashed bracket groups the last three items: "Planning Activities", "Research Assessment", and "Panel Discussion". A red dashed bracket also groups the first four items: "Introduction", "Program Focus & Context", "Current Program", and "Planning Activities".

Note: Panel members are encouraged to ask questions and make comments anytime.

Advisory Committee Objective



Primary objective

- Provide guidance to PIER ESL that will make its DER program a success
- Success defined as focused, cohesive, effective program aligned with PIER Program's goals and ultimately provides benefits to California electricity ratepayers



Advisory Committee Roles



- **Program Review**

- Provide critical, constructive review of ESI DER Program
- Enhance current projects

- **Broader Network**

- Provide virtual extension of program resources by tapping committee's expertise and network
- Brainstorm to develop potential new approaches and initiatives
- Provide linkages and communications

- **Public Support for Program**

- Participate in annual public program review
- Increase awareness of program through committee members' networks and contacts

- **Reporting**

- Provide quarterly reports to PIER ESI DER in form of advisory committee meeting minutes
- Approve ESI DER Advisory Committee annual report that will be suitable for CEC-wide circulation

Advisory Committee Criteria for Membership



- **Representation from one of following stakeholder groups**

- Customer
- Utility
- Other Government (non-CEC)
- Developer
- Equipment Manufacturer

- **Expertise**

- Management competence with technical understanding (Interconnection, Integration, and Grid Effects)
- Understanding of technologies and broader market issues associated with commercializing these technologies; pure technical experts are not desired

- **Other Considerations**

- Access to a large network of people that can be leveraged
- Well respected professional reputation
- Programmatic insight coupled with creativity (i.e., able to find creative ways to address programmatic challenges)
- Energy and passion



Advisory Committee Members

- Scott Castelaz - *Encorp*
- Tom Dossey - *Southern California Edison*
- Pat Hoffman - *U.S. Department of Energy*
- Thomas Hunton - *ASE Americas*
- Rod Sluyter - *Verizon*



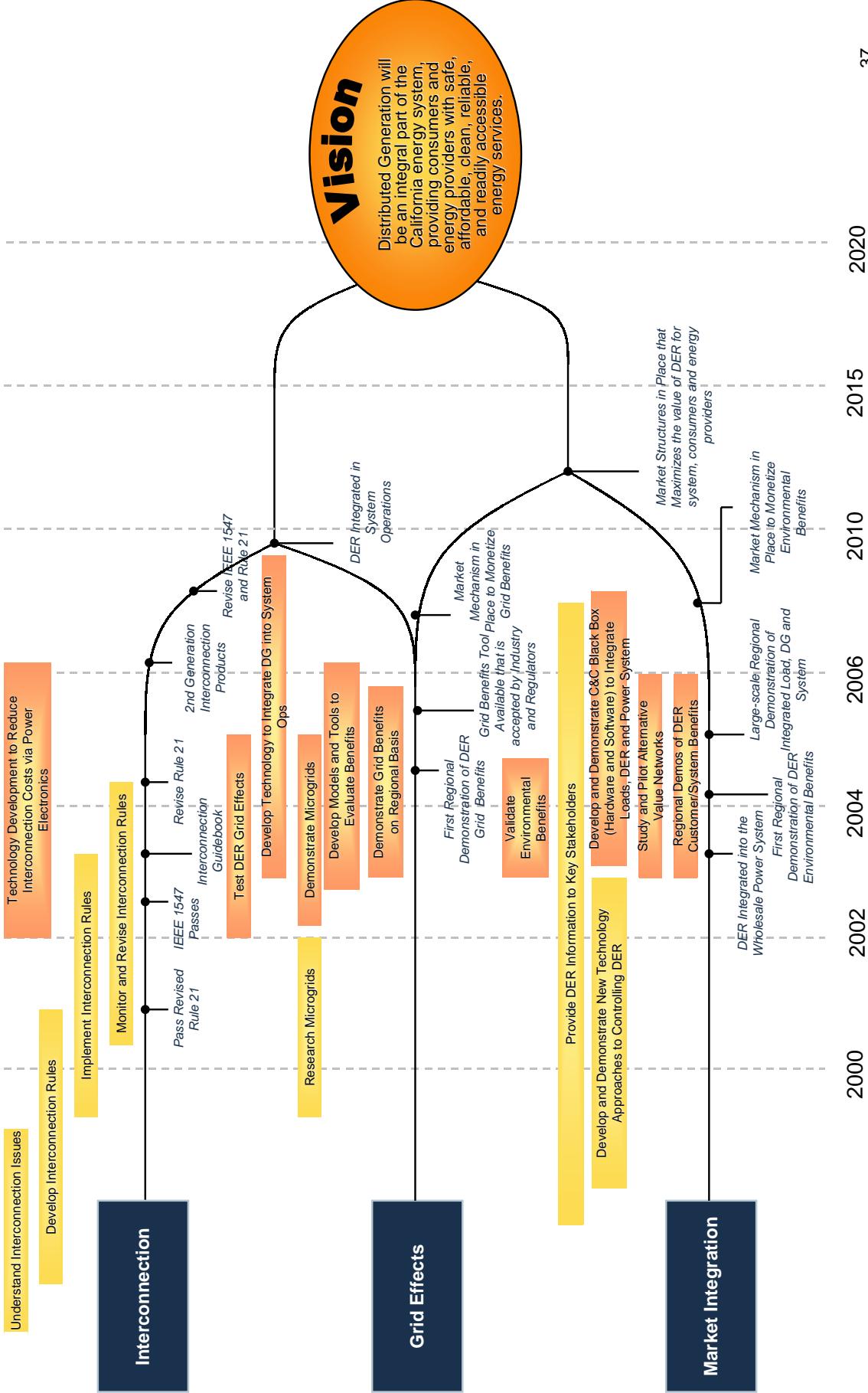


Presentation Topics

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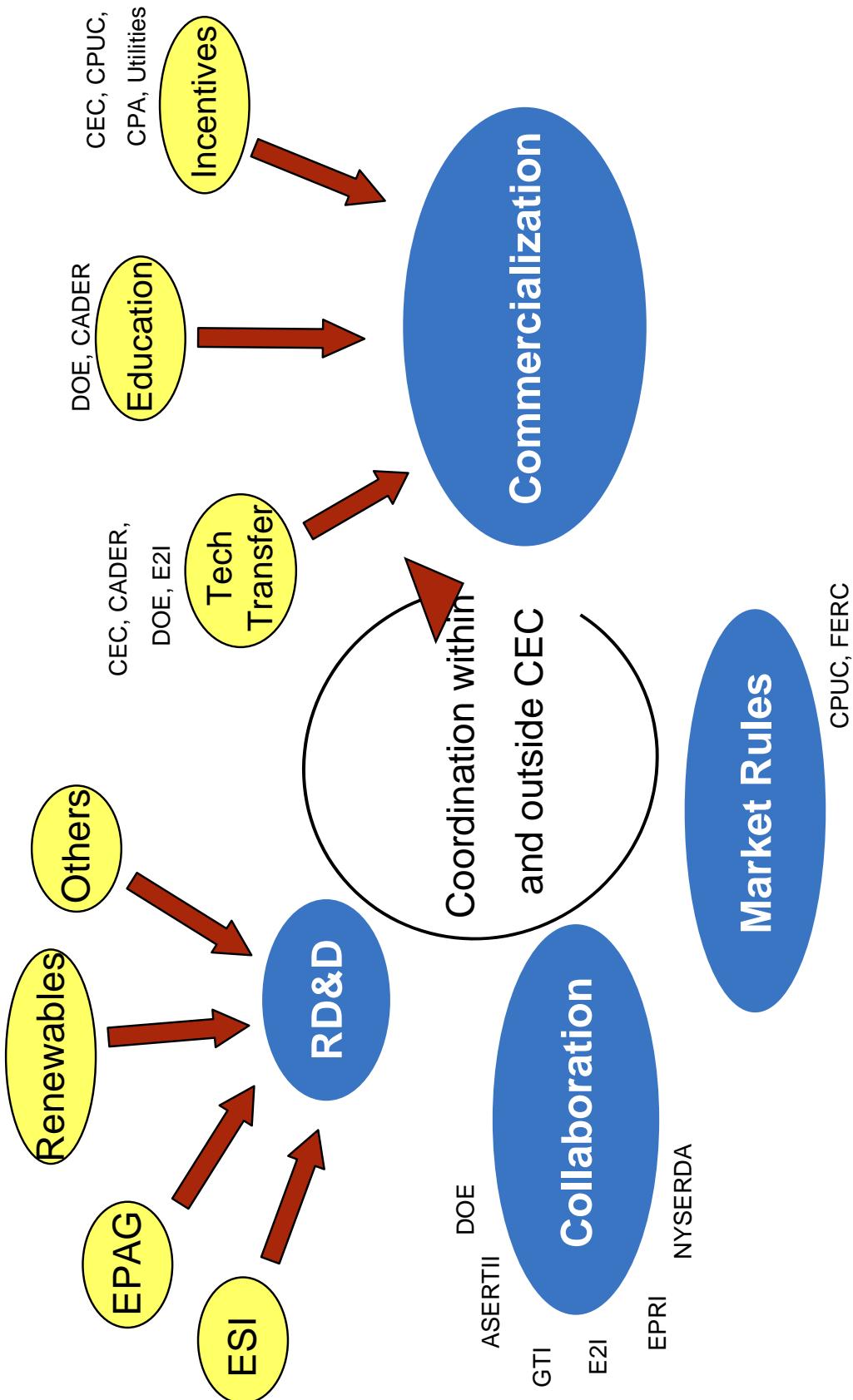
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DER Integration Roadmap



Coordination and Leveraging

ESI has been actively coordinating internally and externally on R&D





Presentation Topics

- Introduction
 - Program Focus & Context
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- Panel Discussion

Panel Discussion



Helpful questions for panel to address

- What is your initial reaction to the portfolio?
- Is the current portfolio of projects balanced?
- Does it contain the right projects?
- What are the trends in industry that will impact the program?
- Are there any external activities with close ties to the project portfolio that should be integrated?
- Where are the research opportunities for ESI to leverage over next one to two years?
- Other?



Distributed Utility Integration Test

William L. Erdman for Susan Horgan
Distributed Utility Associates
Livermore, Ca.

DUIT Project

- Funded by California Energy Commission
- Additional Funding Expected from Department of Energy and Others
- Developed and Coordinated by Distributed Utility Associates – Livermore, CA
- Testing at PG&E Laboratories – San Ramon, CA

DUIT Project

- Measure Impacts of Multiple Interconnected Distributed Generators
- Develop Hard Data on Which to Base Interconnection Requirements
- Address Issues Such as Anti-Islanding, Reliability, Voltage Regulation, Protection
- Input Sought From All Interested Parties (Utilities, Government Agencies, Manufacturers)

DUIT Test Protocols

Anti-Islanding	Fuse Coordination
Voltage Regulation	Capacitor Switching
Substation Backfeed	Adjacent Feeder Faults
Sectionalizer Tests	Power Quality
Cold Load Pickup	Aggregation Control Strategies
Recloser Coordination	Network Systems
Synchronization	O&M Periodic Testing Needs
Short Circuit Current	
System Stability	

Tests in Yellow are initial Tests

DG Technologies to be Tested

Diesel gensets 75 kW and 250 kW	Photovoltaics 1, 2.5, 4, 45, 100 kW
Dual Fuel Engines	Storage Systems 4 kW
Microturbines Qty 2 – 30 kW	Fuel Cell TBD
Induction Motor/ Generator 100hp	Wide Range of Commercially available inverters

Devices in Yellow to be used in initial CEC tests

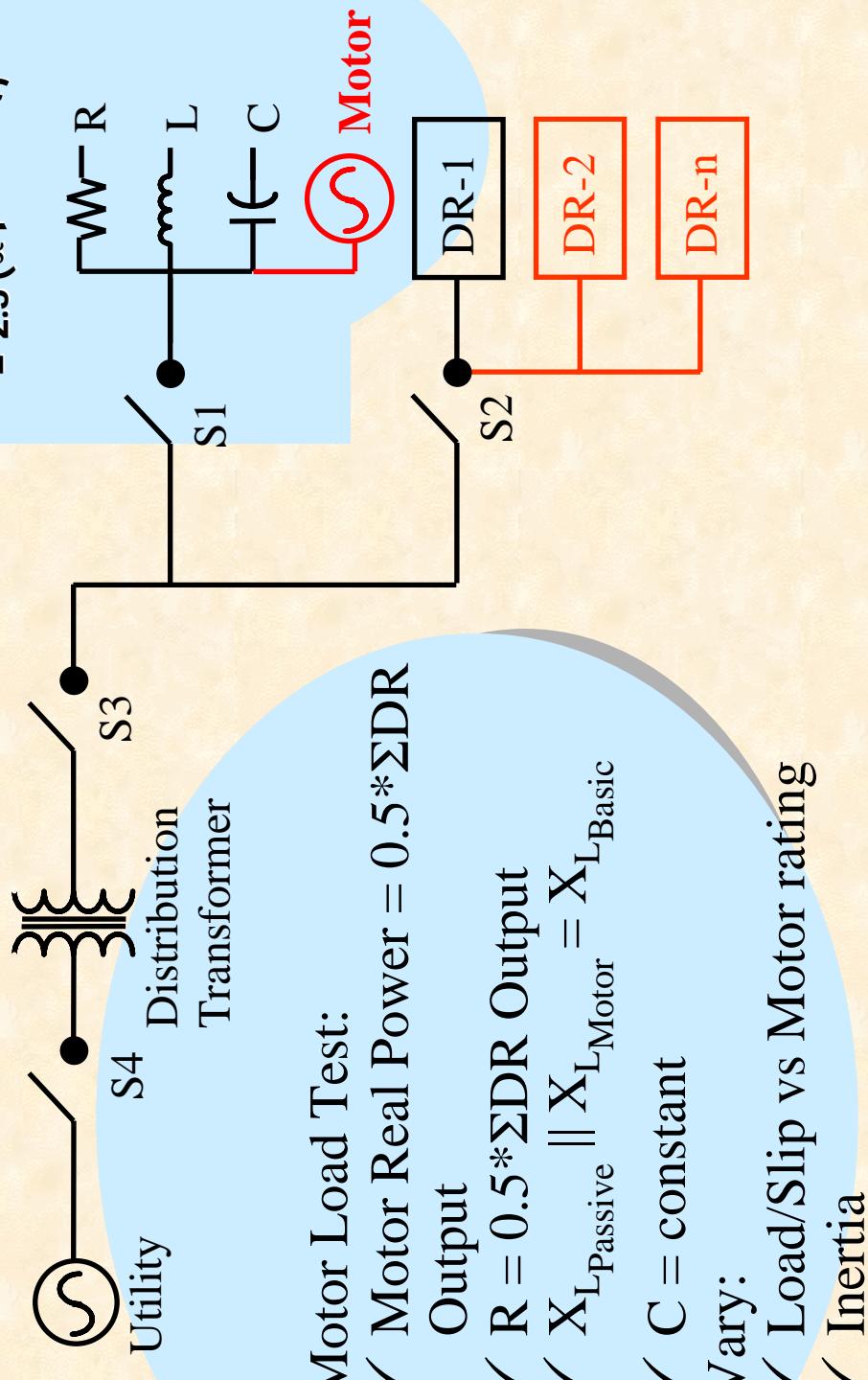
List of DUIT Project Partners

Advanced Energy Inc.	Exelon (Philadelphia Electric Co.)
California Energy Commission	Magnetek Inc.
Capstone Turbine	National Renewable Energy Laboratory (NREL)
City of San Francisco	Pacific Gas & Electric
Cummins Power Generation	Sacramento Municipal Utility District
Distributed Utility Associates	SMA America
Edison Electric Institute	Solar turbines
Encorp	Texas Public Utility Commission
Edecon Engineering	

Some Key Schedule Dates

- Project Kick-off meeting was in 9-20-02
- First Critical project review (Test Plan Focus) in 3-15-03
- Second Critical Project Review Facility Focus in 5-15-03
- Expect to begin acquiring and providing results very shortly after the first critical project review.
- Final report to CEC due 11/1/03

Islanding Test Schematic



**Optimal Portfolio Methodology
for
Assessing Distributed Energy Resources Benefits
for the
EnerynetSM**

November 21, 2002

PIER Project 500-01-039

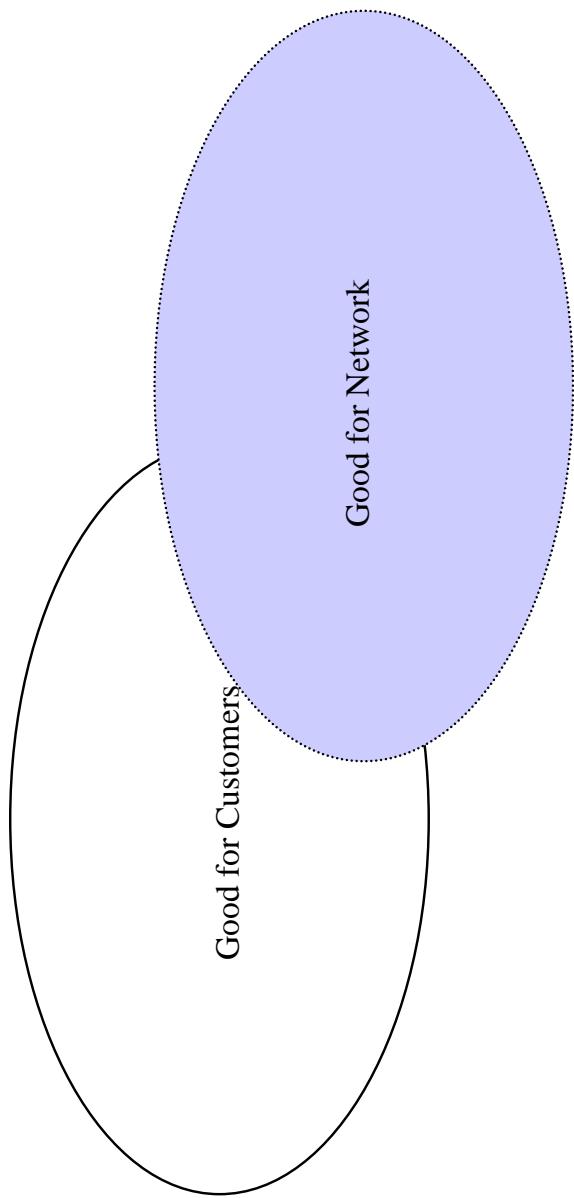
Purpose of Methodology

- Quantify the potential for distributed energy resources (DER) to improve power delivery network performance.
 - Distributed energy resources (DER) include distributed generation, capacitors, and dispatchable demand response.
 - Network performance improvement includes loss reduction, increased load-serving capability, improved stability and power quality.
- Determine the location, size, and operating profile of DER projects that enhance network performance.
- Identify those barriers to DER with the greatest impact on the most beneficial projects.
- Develop non-cost-shifting incentives for beneficial DER projects.

Project Steps

- Model power system as an **Energynet**:
 - Integrated transmission and distribution
 - Embedded generation
 - Loads responsive to system conditions
- Identify additions of real and reactive DER capacity that improve or maximize network performance.
- Characterize DER capacity additions as an "Optimal Portfolio" of DER projects:
 - Distributed generation
 - Capacitors
 - Dispatchable demand response
- Quantify network performance improvement from Optimal DER Portfolio in engineering and economic terms.
- Identify barriers to Optimal DER Portfolio projects.
- Suggest value-sharing incentives for real DER projects.

Why look at DER benefits for the network only?



- Quantifying distinct customer and network benefits of DER permits value sharing to make more projects economic.
 - The Optimal DER Portfolio is not a plan to implement, but a tool for network operators and policy makers.
-

Project Research Benefits

- **Simulation of transmission and distribution as an integrated network.**
 - Direct observation of the impacts of distribution-connected DER.
- **Observation of DER impacts on a broad set of network performance factors.**
- **Use of Optimal Technologies' AEMPFAST® software.**
 - Direct voltage optimization permits precise placement of real and reactive capacity additions.

Proposed Technical Advisory Committee

- ISO/System Operator Representative
- Utility Representative
- University/National Lab Representative(s)
- CEC Representative

Potential Future Uses of This Methodology

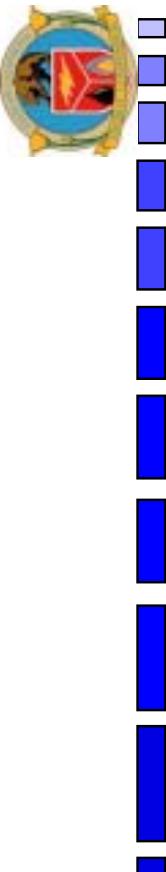
- Analysis of other networks or larger networks (e.g. PG&E's Silicon Valley network or SF Peninsula).
 - Specific evaluation of the potential to use DER as a non-wires alternative to network additions.
- Potential benefits of active/real-time network monitoring and management.
 - Active control of embedded real and reactive capacity devices (such as DER).
- Techniques to ensure system security in the event of unscheduled shutdown of customer-owned distributed generation.
- Potential benefits of automated distribution circuit switching.

Details

- **Project Participants**
 - New Power Technologies
 - Cupertino Electric, Inc.
 - Silicon Valley Power
 - Optimal Technologies (USA), Inc.
 - Rita Norton & Associates LLC
 - Silicon Valley Manufacturing Group
 - William M. Stephenson
 - Roy C. Skinner
- **Status**
 - CEC approved project on June 12, 2002
 - Project kickoff September , 2002
 - Scheduled completion November , 2003

About New Power Technologies

- New Power Technologies identifies and develops businesses and technologies enabling an intelligent energy infrastructure.
- Our core belief is that the electric power infrastructure of the future is an EnergyNet comprised of:
 - Integrated transmission and distribution
 - Embedded (or "distributed") generation with remote generation
 - Loads responsive to network conditions
 - Energy services mass customized to meet customer needs
- Contact Information:
 - Peter Evans 650.948.4546, info@NewPowerTech.com



Demand Response Research Program

Technical Review
November 21, 2002

Ron Hofmann, Program Advisor
Energy Systems Integration Research Program
Public Interest Energy Research Program
California Energy Commission

Acronyms

- CA: California
- CEC: California Energy Commission
- DER: distributed energy resources
- DG: distributed generation
- DR: demand response
- ISO: Independent System Operator
- LC&I: large commercial & industrial
- PIER: Public Interest Energy Research
- R&D: research & development
- RTP: real-time pricing



Why Do DR Research?

- Deregulation in 1996 (AB 1890)
- A few years of calm
- CA energy crisis of 2000-2001
 - Market power (Enron, et al)
 - Aging fossil fuel plants (pollution)
 - Flaws in deregulation (AB 1890)
 - Disconnect between wholesale and retail prices

Summer 2000

- CA ISO had 32 Stage 1 alerts (<7% reserves)
- CA ISO had 17 Stage 2 alerts (<5% reserves)
- Shed firm load in San Francisco on June 14
- High levels of system disturbance in West



Winter 2000-1

- December 7th first Stage III is declared
 - DWR drops 200 MW of pumping load to avert rotating blackouts
- 20 consecutive days in Dec. of Stage I or II alerts
- State under Stage III alerts Jan 16th - Feb 16th
- Statewide rotating blackouts
 - 3 days in January
 - 2 days in March
 - 2 days in May 2001

State Takes Action

- Update Efficiency Standards
- Rebate/Incentive programs
- Public Awareness Campaign
- Business Partnerships
- 20/20 Rebates
- Retail Rate Increases
- Media Hype



Long-Term Options

- Build more plants (supply approach)
 - Replace aging (dirty) fossil fuel plants
 - Increase in-state supply
 - Add peaker plants (costly, NIMBY)
- Use load as a resource (demand approach)
 - It doesn't take much to DR to mitigate market power
 - There is a lot of potential load resource
- DR becomes significant CEC policy initiative
 - championed by Commissioner Art Rosenfeld
- PIER begins to develop a DR program plan

What is DR?

- DR is the action required to reduce load when:
 - Contingencies occur that threaten supply-demand balance, and/or
 - Market conditions occur that raise supply costs
- DR typically involves peak-load reductions
 - DR strategies are different from energy efficiency, i.e., transient vs. permanent



Vision for DR

- Create a real-time, automated DR infrastructure that is simple to use and can adaptively respond to changing contingency and market conditions
- A DR infrastructure must coexist with legacy systems, allow for future technology and tariff improvements, and have near-, medium-, and long-term benefits to California taxpayers

History

- In 2001, PIER commissioned 3 scoping studies which resulted in the following reports
 - “Real Time Pricing in California, R&D Issues and Needs”, by Ahmad Faruqui, Joe Hughes, and Melanie Mauldin;
 - “Load As a Reliability Resource in Restructured Electricity Markets”, J. D. Kueck, B. J. Kirby, J. Eto, R. H. Staunton, C. Marnay, C. A. Martinez, C. Goldman; and
 - “Advanced Meter Scoping Study”, Levy Associates.

History (Cont'd)

- These scoping studies led to a November 16, 2001 roundtable discussion between members of
 - CEC: Art Rosenfeld, Mike Jaske, Mike Messenger, John Wilson, Pat McAuliffe, Karen Herter
 - PIER: Terry Surles, Laurie ten Hope, Mark Rawson, Linda Kelly, Martha Brook, Chris Scruton, Jamie Patterson, David Michel
 - Consultants: Joe Hughes (EPRI), Ahmed Faruqui (Charles River), Joe Eto (LBNL), Michael Kitner-Meyer (PNNL), Carl Blumstein (UCEI), Chuck Goldman (LBNL), Roger Levy (Levy Associates)

History (Cont'd)

- The following questions were addressed

- Market DR:

- » Is there a role for DR in an unregulated power industry?
 - » Does RTP play a role in a regulated market? If so, how would it work?
 - » Is it important for there to be real-time metering standards?
 - » What are the policy, institutional, and market barriers to RTP?
 - » Is RTP as a DR strategy really better than TOU?
 - » What are the statuses of RTP enabling technologies? Real-time meters? Billing? Local controls? Communications? Thermostats? Internet software?

History (Cont'd)

- Contingency DR:
 - » What types of customer loads are best suited to provide DR?
 - » Which ancillary services are the low-hanging fruit for DR?
 - » Are distributed energy resources (DER) really an economic form of DR?
 - » Can DLC (direct load control) ever be made acceptable to end-users? Is it possible to justify?
 - » What are the enabling technologies?
- Overall:
 - » Is the research agenda the same, regardless of the policy objective (e.g., market DR vs. contingency DR; reduce customers' bills; mitigate market power; system protection, etc.)?
 - » What's the value of the "reliability insurance" DR provides? Is that an appropriate research question?

History (Cont'd)

- The primary conclusions from the roundtable were
 - Real-time pricing should be a building block for a long-term/permanent DR capability in California
 - Real-time metering technology is cost-effective for large commercial and industrial (LC&I) customers
 - Real-time technology is still too expensive for implementing a statewide real-time signaling infrastructure that includes residential customers
 - The CPUC lacks the market information it needs to assess the implementation of real-time pricing tariffs
 - The California ISO needs help to establish a DR R&D agenda for making loads responsive to their needs

Program

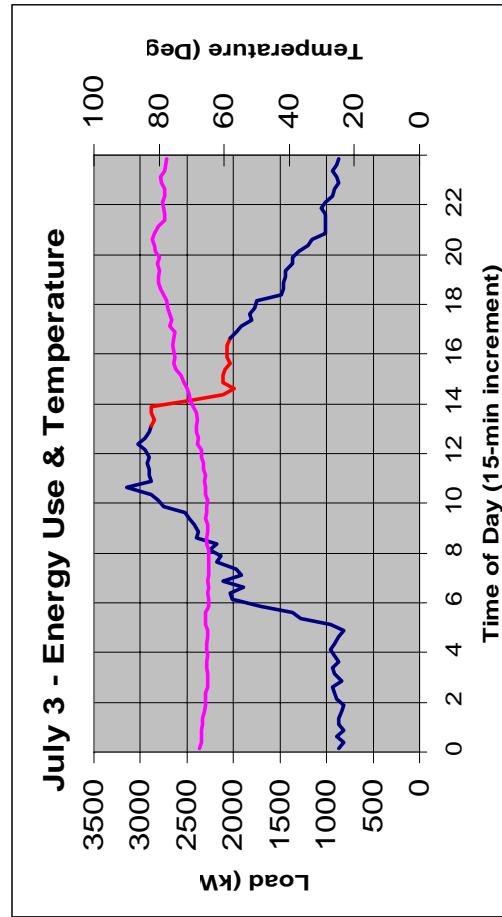
- Five DR project areas were created
 - Demonstrations and Case Studies
 - Enabling Technologies Development
 - Market Information Development
 - Test Bed and Tariff Development
 - CA ISO Support
- Four specific projects have been funded
 - LC&I DR Demonstrations and Case Studies
 - Leveraging UCB/CITRIS Technologies
 - RTP DR Program Experience in New York
 - CA ISO Research Agenda Development

Demonstrations & Case Studies

- LC&I DR Demonstrations and Case Studies
 - Mary Ann Piette, Project Manager
 - Lawrence Berkeley National Laboratory
 - \$446,000
- Project objectives
 - Stake in the ground study to establish state-of-the-art DR capabilities and R&D needs
 - Send a dynamic tariff to LCI&I buildings
 - Determine automatic DR capability
 - Report results in a form that will help make policy and R&D decisions possible

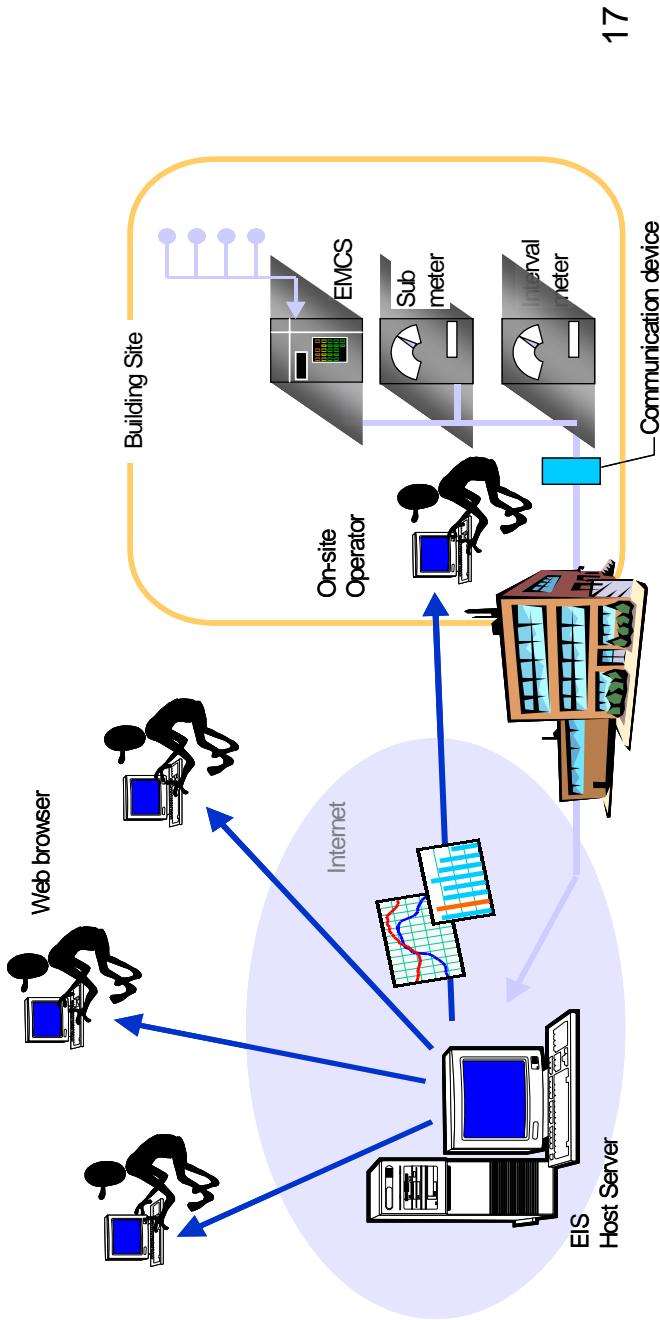
LC&I Case Study Objectives

- Improve understanding of the status of automated DR in buildings
- Quantify DR savings of automated systems
- Identify technology gaps to improve future systems
- Understand key features of the market and decision making perspectives
- Develop and test a real-time signal to initiate an automated demand response



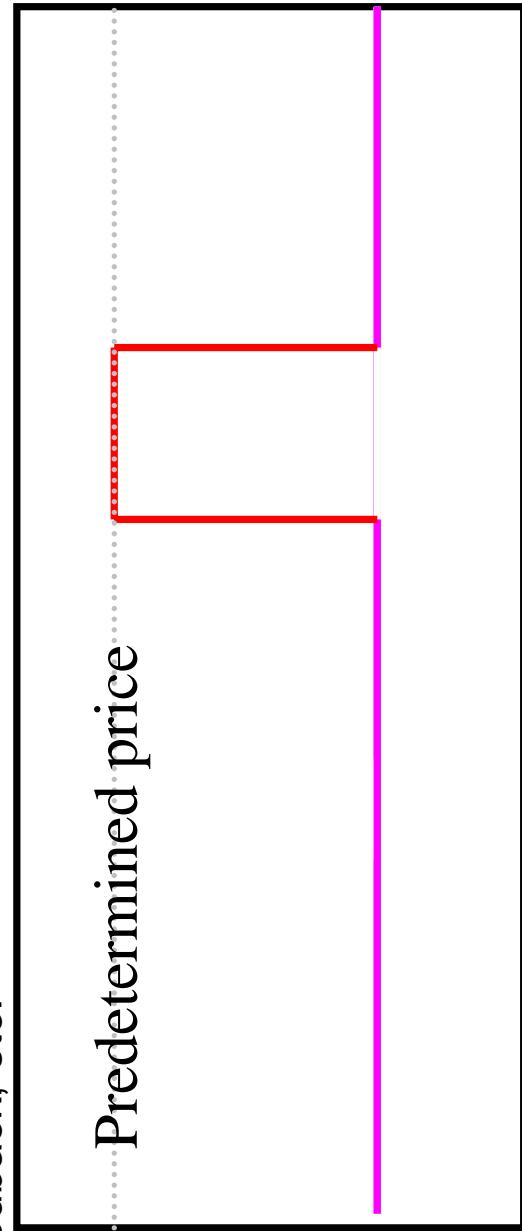
LC&I Case Study Tasks

- Task 1. Assess State-Of-The-Art DR Technology & Develop Terminology
 - Hardware, software, middleware, communications protocols, DR applications
- Task 2. Assess Existing Documentation & Develop Selection Criteria
 - Building types, sizes, ownership, technology suites, location, etc.



LC&I Case Study Tasks (Cont'd)

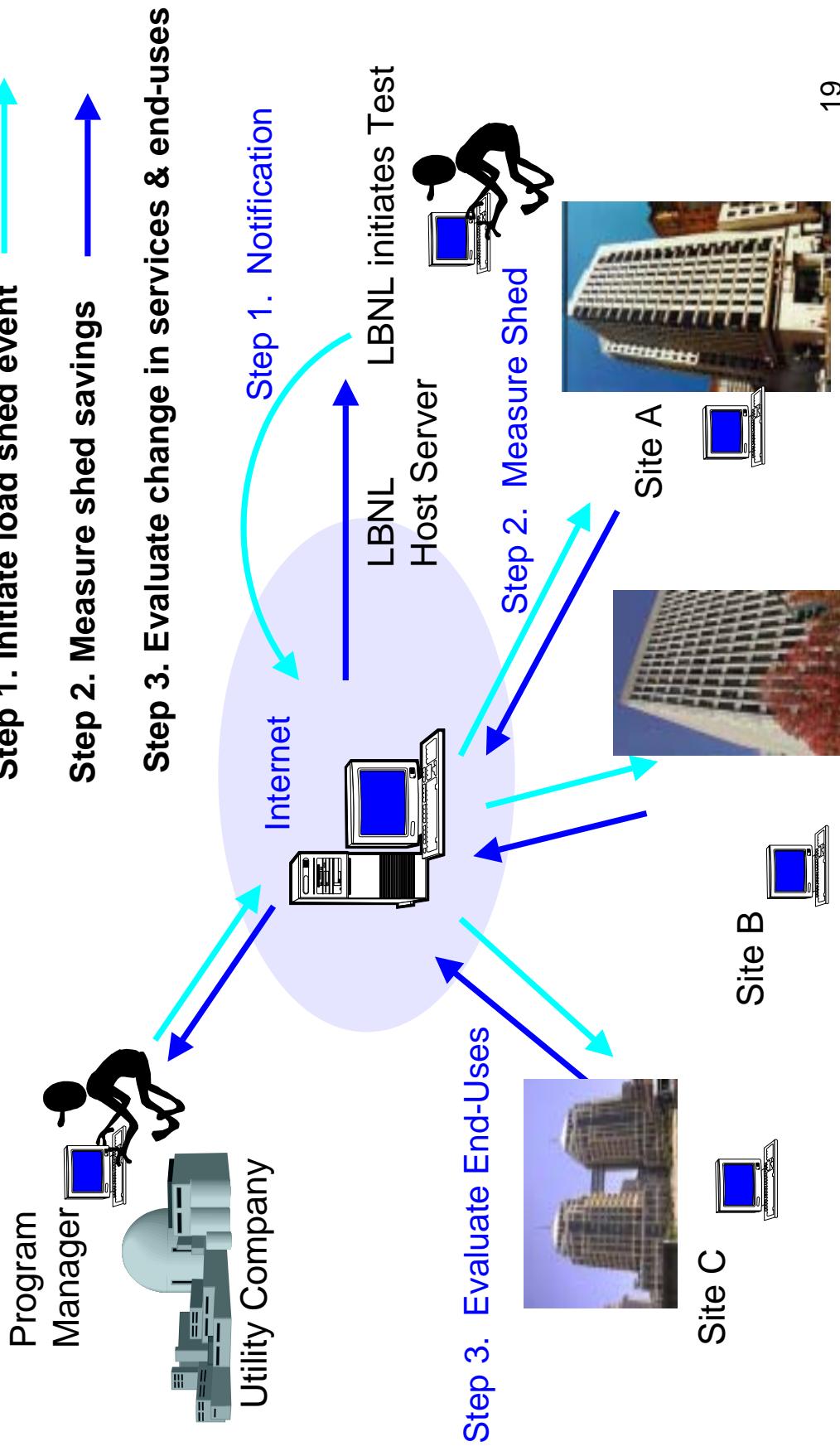
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 - Examine end-use savings, costs of systems, ease of use, operator feedback, etc.



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How Does Automated DR Perform?



Enabling Technologies Dev.

- Leveraging UCB/CITRIS Technologies
 - Gaymond Yee, acting Project Manager
 - California Institute of Energy Efficiency (CIEE)
 - University of \$3,000,000
- Project objectives
 - Leverage DoD and other University of CA funding
 - 10/10 improvement in capabilities and cost
 - Totally integrated communicating sensors and controls
 - Develop new ways to meter, monitor and control DR-related equipment
 - Explore new ways to manage networks

UCB/CITRIS Strengths

- Pico radio (Jan Rabaey)
 - Low-power wireless communications
- TinyOS (David Culler)
 - Self-organizing networks
- Smart Dust (Kris Pister)
 - Integrated communicating sensors and control
- Low-cost packaging (Paul Wright)
- Energy scavenging and storage (Paul Wright)
- Energy efficiency (Ed Arens, Cliff Fedderspiel)

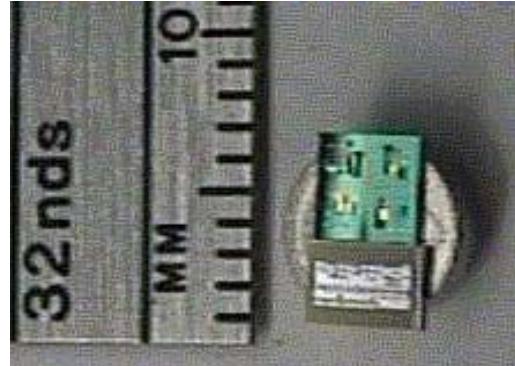
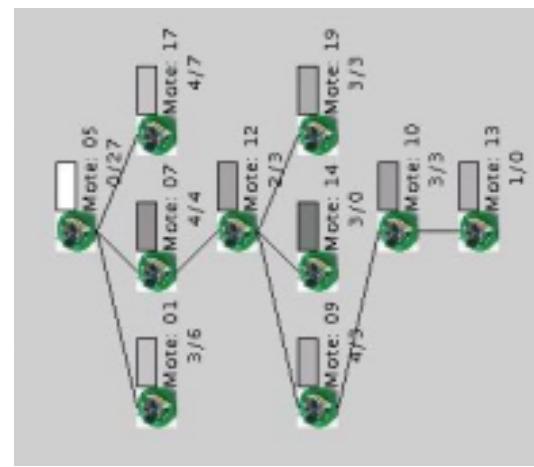


UC Berkeley Technologies



Pico radio

Ultra-low energy
($<5\text{nJ/bit}$)
Ultra-low power
($<100\text{\mu W}$)



TinyOS

Event-based
operating system for
sensor networks.

Smart
Dust
Ultra-
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($<1\text{ mm}^3$)

Research Underway



■ Objective

Determine how small, wireless, multi-modal sensing technology could affect the operation of buildings

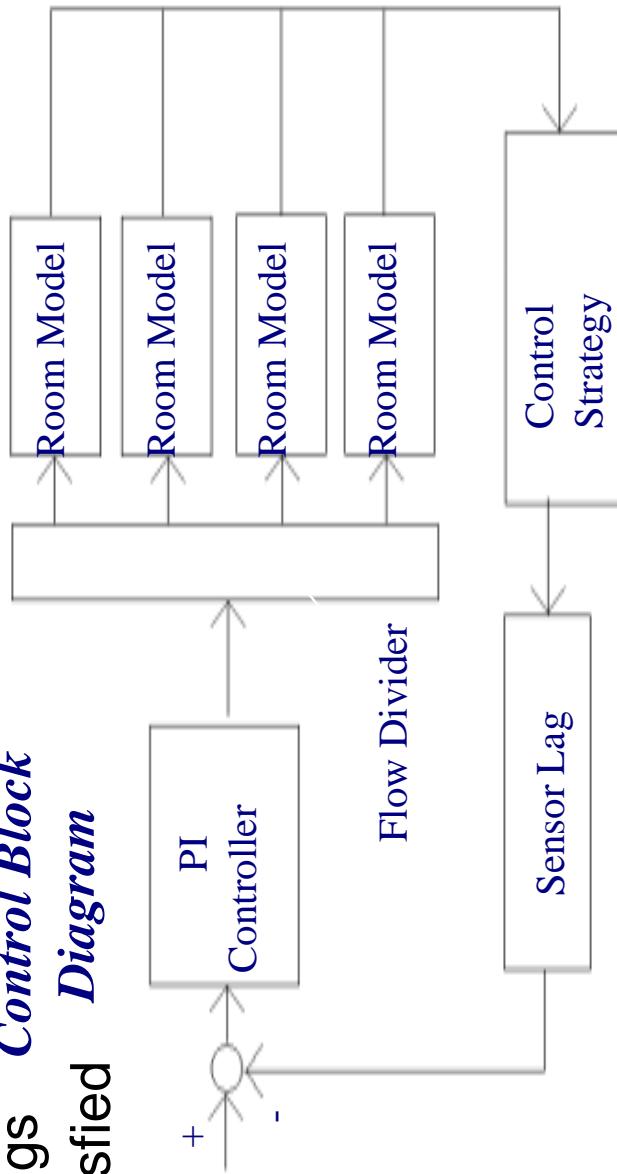
■ Issues

- What should we measure?
- Location?
- How do we use the info?



Wireless Temperature Control

- Multi-Sensor, Single Actuator
 - Replace single sensor with sensor network
 - Computer simulation
 - 9% energy savings *Control Block Diagram*
 - 6% fewer dissatisfied
- ICEBO paper
- Improvement occurs when some spaces need heating and others need cooling at the same time

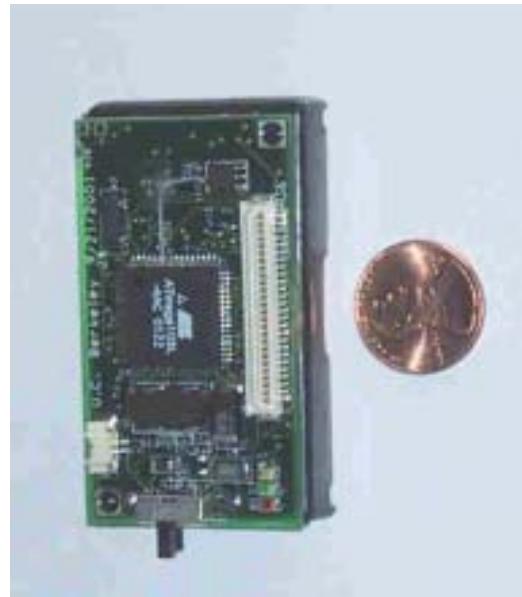


Wireless Temperature Control

- Design application in TinyOS
- Use TinyDB to query the sensor network

- Mica motes
- Places

- Unoccupied room
- Student offices
- Computer labs



Power Scavenging



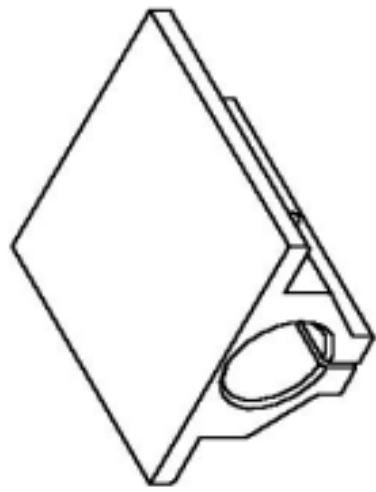
- From flow

- 400 mW at 1200 fpm
- 60 mW to power motes



- From heat transfer

- 8000 mW/cm² at $\Delta T = 140^{\circ}\text{F}$ (steam pipe)
- Wire-free actuation?



DR Research Objectives

- A totally integrated, self-powered communicating meter platform that costs < \$10 in physical parts and enables a total installed cost of <\$25
- A real-time DR-responsive thermostat that costs less than \$30 installed and can automatically implement a user's desires without the user having to learn an arcane programming procedure
- Dynamic communications networks that support legacy equipment and allow new equipment from multiple vendors to join the networks

Market Information Development

- RTP DR Program Experience in New York
 - Chuck Goldman
 - Lawrence Berkeley National Laboratory
 - \$265,000
- Project objectives
 - Assess customer response to tariffs based on day-ahead wholesale market prices (i.e., RTP) in a retail competition environment
 - Assess relative merits and relationship between alternative programs/strategies that seek to increase customer participation in electricity markets

The Research

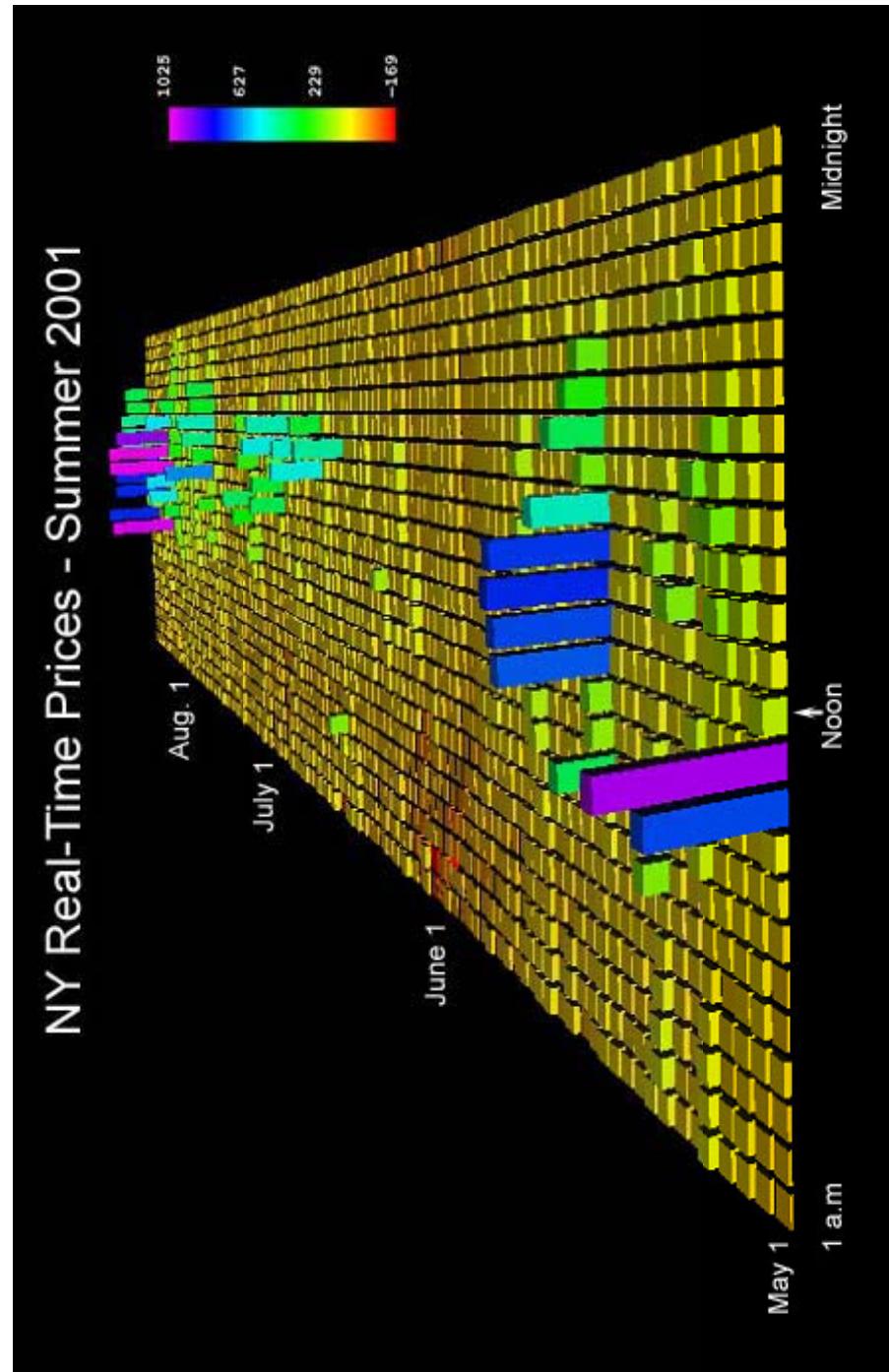
- Assess customer response to dynamic pricing tariffs and other strategies to increase demand response
- Study dynamic pricing and DR programs in New York (NY) State that have attracted significant participation and support from large customers for four years in a restructured and well-functioning electricity market
- Evaluate the NY experience with respect to how it might be used in California to create Price-Responsive Load

The Research (Cont'd)

- Case Study conducted in two phases
- Phase 1: Initial scoping analysis
 - Analysis of customer bills to estimate demand elasticity
 - Interviews with policymakers and key stakeholders on regulatory process and key policy issues to resolve
- Phase 2: Comprehensive analysis
 - Analysis of how and why customers respond through customer market survey
 - Combine billing and customer survey data to develop customer behavior and performance models
 - Comparison with control group on fixed price tariffs
 - Assess implications & lessons learned for CA's electricity market.



Wholesale Market Price Topology



Significant Findings to Date

- Project started in October 2002
- Initial interviews conducted with NY regulatory staff and industrial customer trade association
- This work could provide useful information for the DR Order Instituting Rulemaking (OIR) process currently underway
- Forming Stakeholder Advisory Group to provide input on project work plan, key questions/issues on RTP for CA customers and policymakers

Test Bed & Tariffs Development

- No projects yet
- Test beds mean sustainable infrastructure
 - San Francisco Hunters point
 - Munis with supply problems
- No more utility pilots that are torn out
- Collaboration with NYSERDA



- CA ISO Research Agenda Development
 - Brendan Kirby
 - Oak Ridge National Laboratory
 - \$125,000
- Project purpose
 - Understand why responsive load been a greatly under-utilized resource for addressing power system adequacy and reliability
 - Understand how responsive loads could be used by the CAISO in a region with transmission and generation constraints, e.g., San Francisco with transmission and generation constraints

The Research

- Develop a research agenda for using responsive load as a system reliability resource
- Work with CAISO personnel to develop a research agenda to identify
 - How responsive loads could increase power system reliability and adequacy
 - What behaviors are desirable
 - What reliability services (ancillary services) these loads could provide



The Research (Cont'd)

■ Write up the research agenda

- Identify long-term and short-term goals including a vision of how the power system of the future should interact with loads.
- Identify specific research areas to further short-term and long-term goals. These may include developing solutions to institutional, economic, and technical problems. They may include projects aimed at developing confidence in new approaches for individual loads, the CAISO, and/or regulators.

Questions for Committee

- Do you believe that the DR Program Plan is focused on the proper project areas?
- Do you believe that the DR R&D projects that we have started are useful?
- Do you believe that the R&D teams we are using are among the best available?
- Are we missing major collaborative opportunities?
- Is the DR R&D worth scaling up?

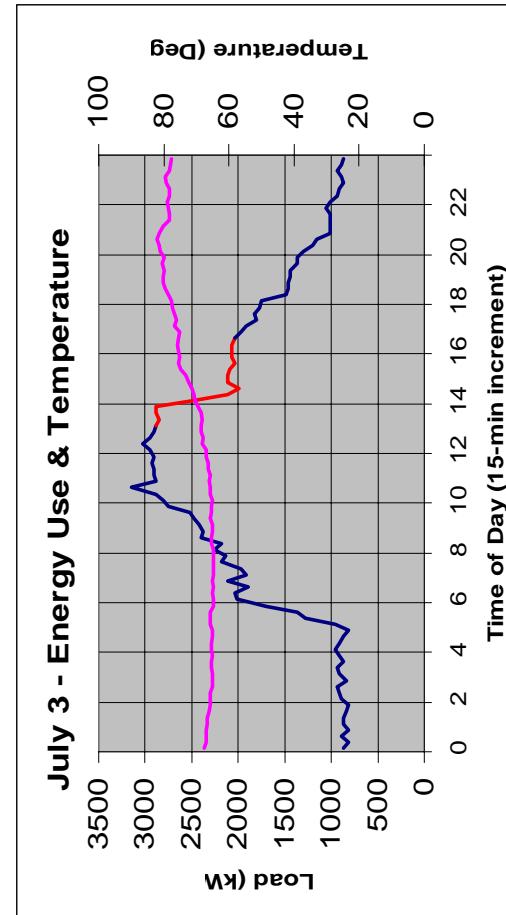


Large Commercial, Industrial, and Institutional (LCI&I) Demand Response (DR) Demonstrations and Case Studies

Karen Herter, Lawrence Berkeley
National Laboratory
Presentation to the California
Energy Commission
November 21, 2002

LC&I Case Study Objectives

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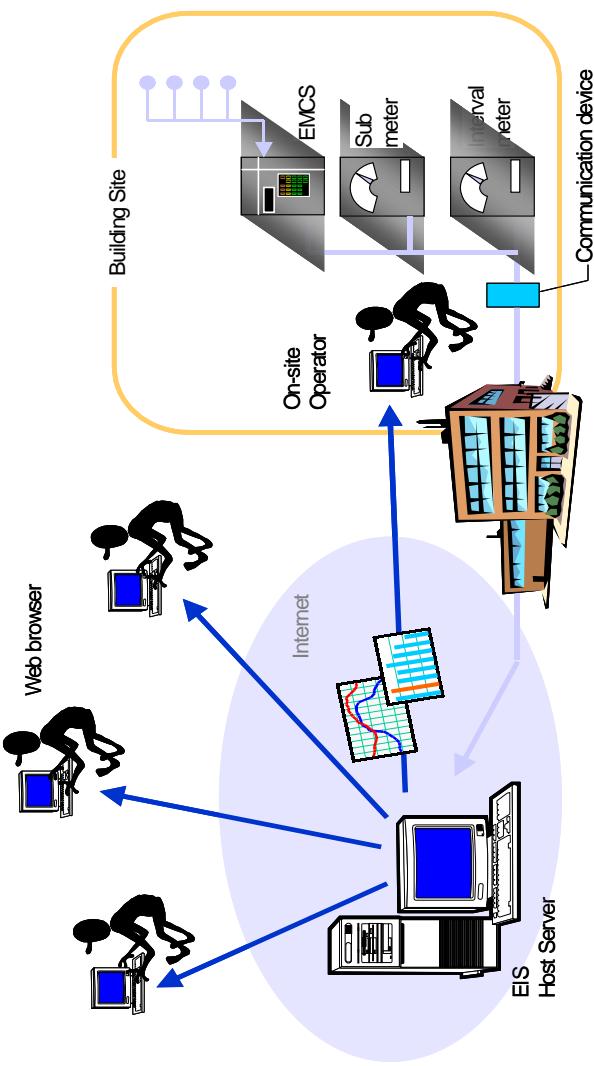


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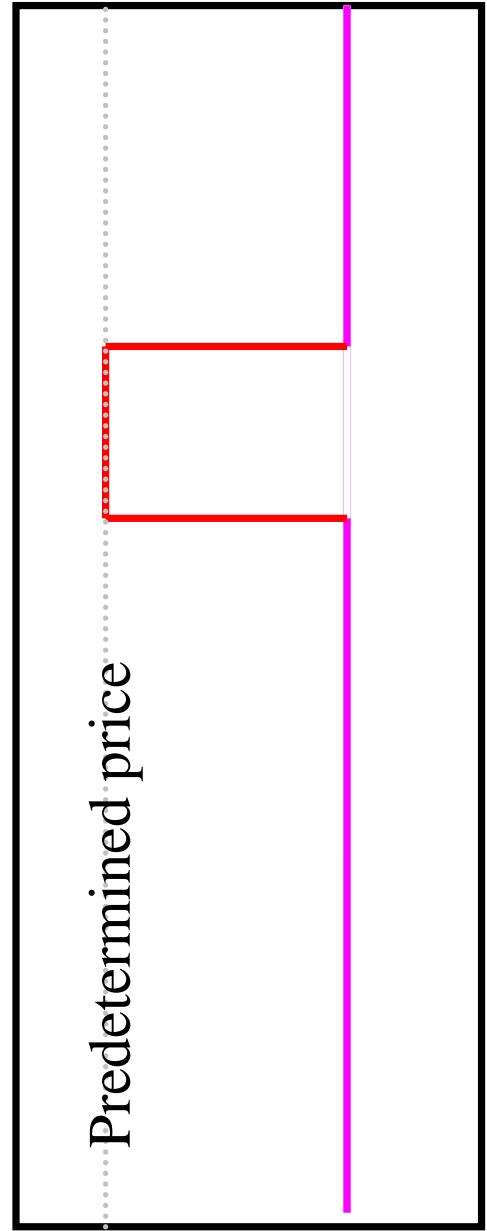
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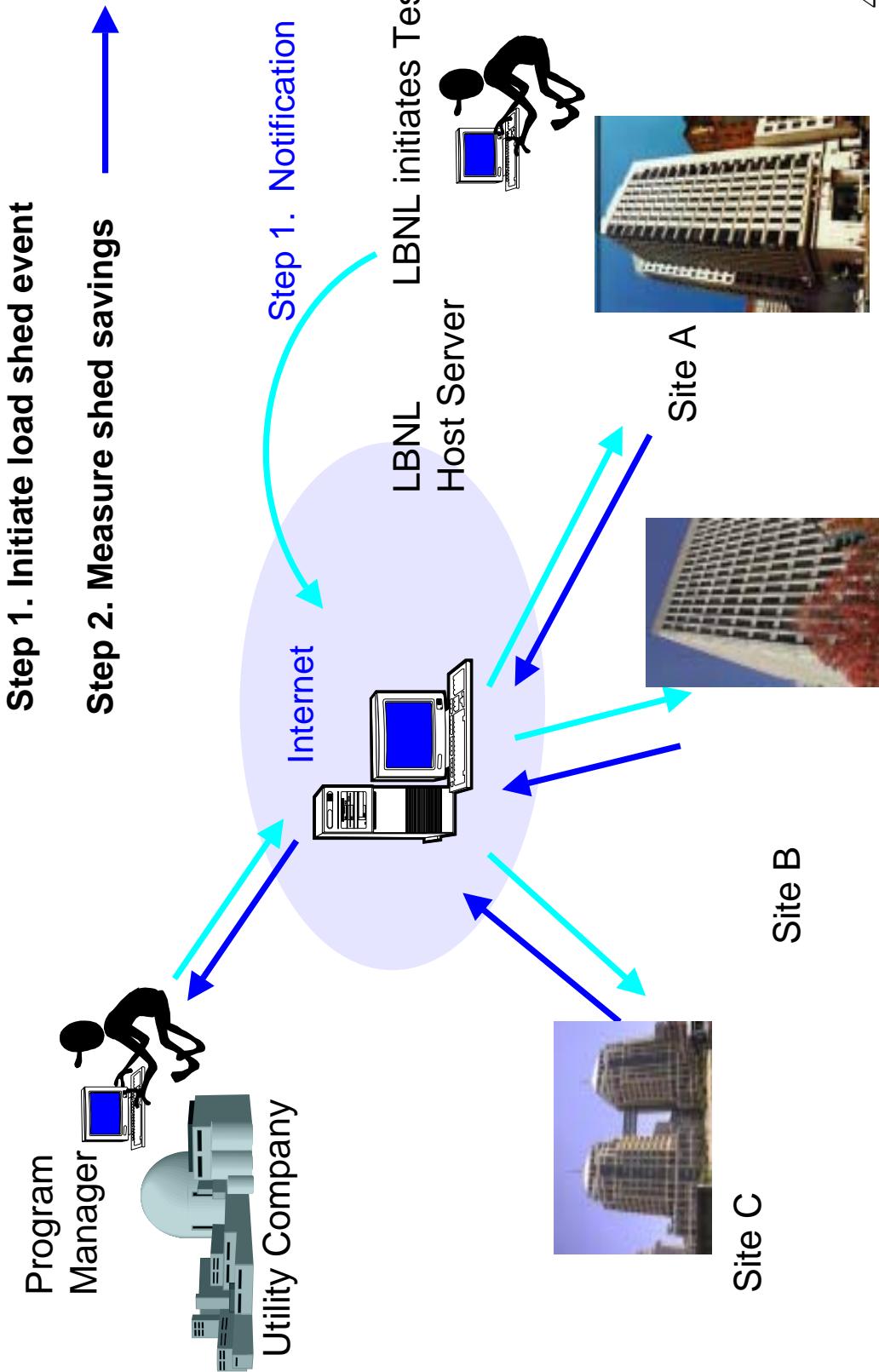


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How Does Automated DR Perform?





Leveraging UCB/CITRIS Technologies

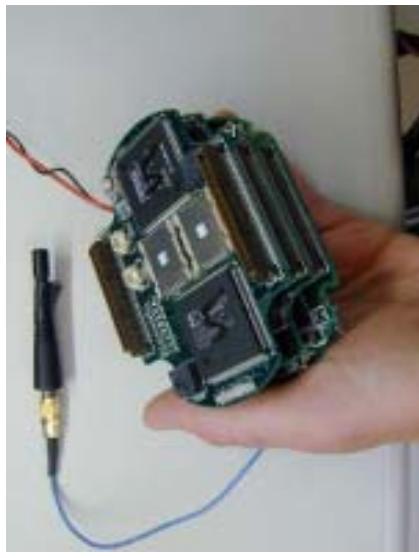
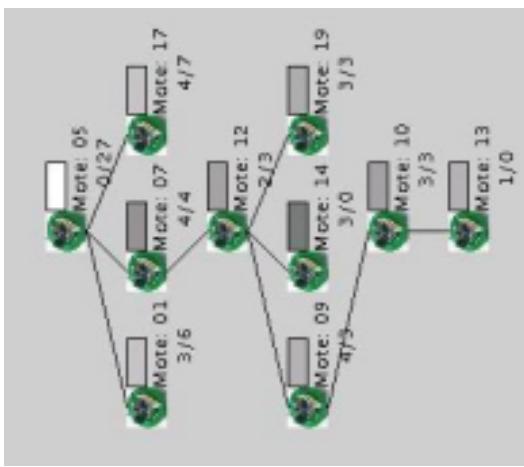
Clifford Fedderspiel, Center for the
Built Environment, UC Berkeley
Presentation to the California
Energy Commission
November 21, 2002

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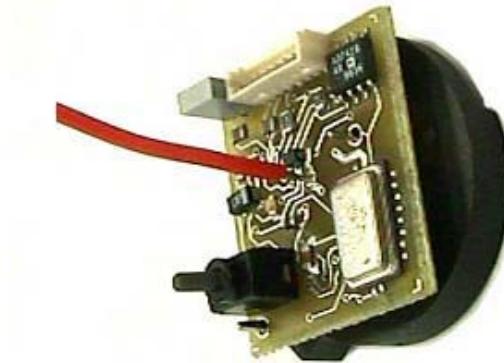


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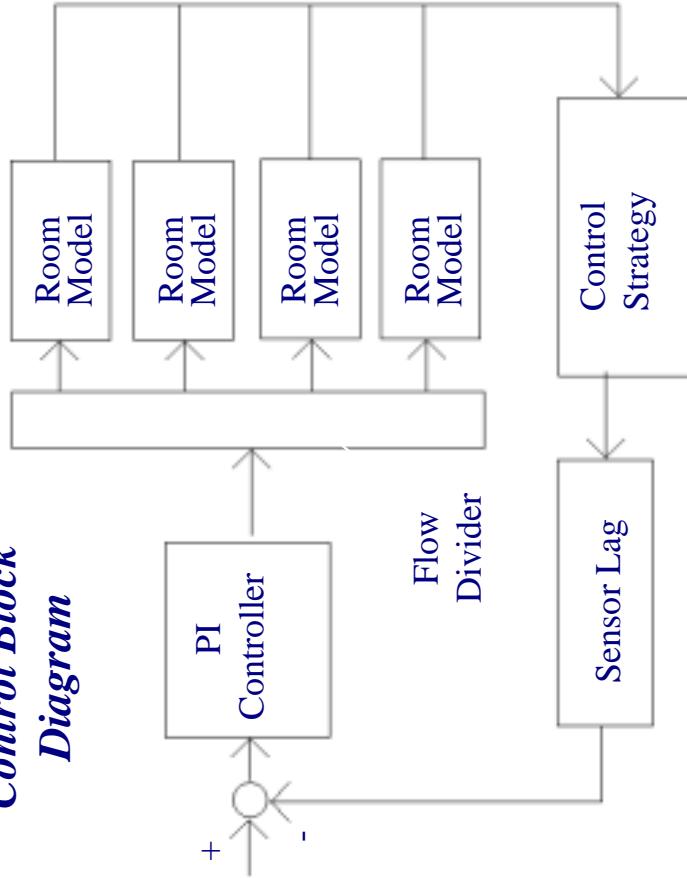


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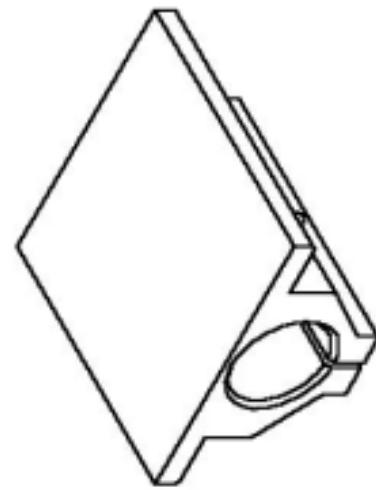
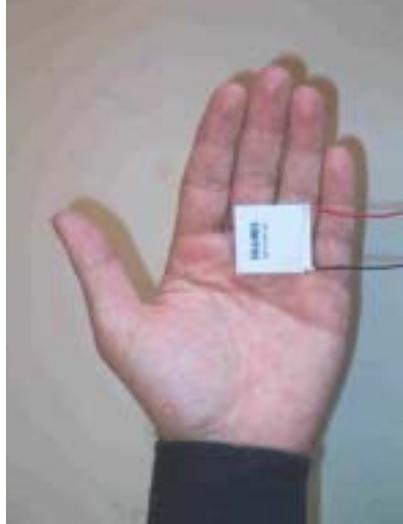
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Transmission Research Plan

Technical Review

November 21, 2002

**Overview & Background - Laurie ten Hope
Strategy for the Future - Linda Kelly**

Energy Systems Integration Research Program

Public Interest Energy Research
California Energy Commission

History



- In 1996, AB 1890 established the principles and public benefit surcharge, “To insure continued funding for energy-related public interest RD&D during the transition to a more competitive environment.”
- SB 90 identified key subject areas for PIER
- Legislature directed CEC to develop PIER Program
- Initially, CPUC was directed to allocate non-T&D PIER funds to support the program

The Original Program

- PIER Transmission R&D was initially presumed to be limited to EMF research (funded at \$700k)
- Transmission R&D was envisioned as an area that would be adequately provided for by competitive and regulated markets

Concerns Result in New Projects

- 1996 West Coast outage occurs
- Concerns about the reliability and stability of the transmission and distribution system are raised.
- Utilities lobby for help to protect the transmission and distribution system and maintain its reliability
- PIER reacts and funds many projects, primarily from IOUs

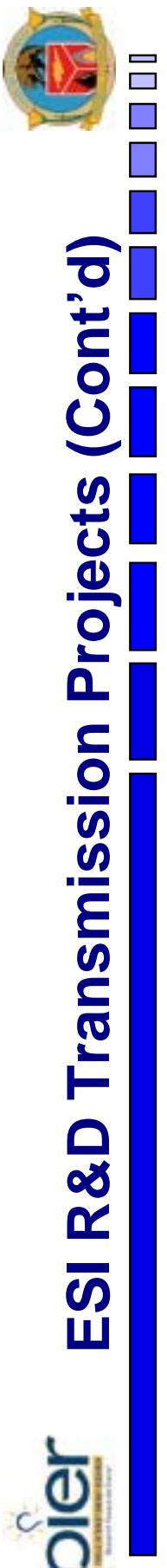
ESI T&D Transmission Projects



In 1998 and 1999 ESI contracted with IOUs to do the following research:

- Electric System Seismic Safety and Reliability w/ PG&E
- Dynamic Circuit Thermal Line Rating w/ SDG&E
- System Stability and Reliability:Flexible AC Transmission Systems (Facts) Benefits Study w/ SDG&E
- Phasor measurement Units w/ SCE
- USAT MOD-2 w/ SCE
- Energy Source Stabilizer w/ SCE
- Substation Reliability w/ SCE

ESI R&D Transmission Projects (Cont'd)



Private sector contractors funded to do the following R&D:

- Development of a Real-Time Monitoring Dynamic Rating System for Overhead Lines w/ EDM
- Development of a Composite Reinforced Aluminum Conductor w/ W. Brandt Goldsworthy
- Light Activated Surge Protection Thyristor (LASPT) for distribution system reliability with OPTI-Switch
- Intelligent software agents for control & scheduling of distributed generation w/ AESC
- Sagging Line Mitigator (SLiM) with Material Integrity Solutions
- Interconnect requirements w/Onsite
- Secondary distribution impacts of residential EV charging w/NEETRAC
- EPRI targets

Intergovernmental Collaboration



- As the restructured market took shape, system reliability and management emerged as critical need
- Seeking to develop partners and leverage limited research funds, PIER, through an intergovernmental agreement, awarded \$7.2 million to support a three-year research program conducted by Lawrence Berkeley National Laboratory (LBNL) for the Consortium for Electric Reliability Technology Solutions (CERTS).

Intergovernmental Collaboration (Cont'd)



- This project is leveraged with \$11.8 million in match funds.
- Developed into cornerstone of ESI's program: providing RT grid impact tools to CAISO; integrating DR & DER solutions to system and connected CEC program with major players

When the Dust Settled

- There was a lot of R&D research being funded, but how it would balance risks, benefits to ratepayers over time and connect to the market was not clear
- Decision was made to continue only with R&D projects that enhanced near-term transmission system reliability and efficiency. Distribution projects were suspended
- Projects that did not specifically meet this criteria did not receive additional funding. These projects will be reviewed for relevancy as part of the process that develops an ESI Transmission Plan

Three Featured Projects

- The Valley Group - Don Kondoleon
- CERTS - Joe Eto
- SLiM - David Chambers





Development of a Research Agenda - Linda Kelly



Transmission Research Program

**Developing a Strategy
for the Future**

**Technical Review
November 21, 2002**

Linda Kelly, Program Manager
Energy System Integration Research Program
Public Interest Energy Research Program
California Energy Commission

Developing a Strategic Transmission Plan



Steps:

- Comprehensive understanding of what R&D is being done in both the public and the private sector
- Assess what public benefit research will provide most value to California and its citizens.
- Find and establish collaborative partnerships to leverage PIER funds
- Develop and implement a plan that will fund projects that will enhance the reliability and increase utilization of the electric transmission system in the state of California



Current working definitions

- **Short-term.** Develop advanced technologies needed to improve reliability, operability and efficiency of the transmission delivery grid
- **Long-term.** Develop advanced technologies that automate grid operation

Public Benefit Evaluation



Purpose of Criteria

Establish threshold criteria that will be used to determine which Transmission R&D efforts conform to the statutory definition of “Public Interest Research.”

Public Benefit Evaluation (Cont'd)



Criteria

Criterion 1. Improve the quality of life and provide public value for the benefit of California and its citizens through the advancement of science or technology through energy research, demonstration and development projects that will improve:

- » Environmental quality,
- » Public health and safety,
- » Energy cost/value
- » Other tangible benefits

Public Benefit Evaluation (Cont'd)



- **Criterion 2.** Improve the reliability, efficiency and quality of the transmission and distribution system.

- **Criterion 3.** It is unlikely that this research will be pursued by the competitive or regulated research sectors.

Public Benefit Evaluation (Cont'd)



Principles

These will help determine which R&D is not likely, in whole or in part, to be funded by the private sector.

- **Principle 1.** Probability of success too low or payback time too long for private sector to invest (e.g. long shots/early state of research).
- **Principle 2.** Financial costs too high (e.g. no single or group of private companies can finance R&D).

Public Benefit Evaluation (Cont'd)

- **Principle 3.** Market and regulatory barriers/uncertainty would inhibit successful implementation (e.g. uncertainty about tariffs to cover investment/customer for technology unknown).
- **Principle 4.** T&D develops “basic information” that is non-exclusive
- **Principle 5.** Public concerns identified as requiring R&D. Suggests that the public sector will do it.



Providing Balance

- Risk
 - Conservative vs. innovative
- Timing
 - Short, medium, and long-term
- Research outcomes
 - Relative to PIER objectives
 - Benefits to all sectors that contribute to funding

Research Assessment and Gap Analysis

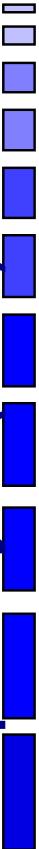


This work is under development and includes the following:

- Survey R&D activities in public and private sector
- Evaluate CEC R&D projects
- Assess R&D gaps relative to established research area
- Develop a balanced portfolio of R&D activities/ projects that are appropriate for PIER funding

- Schedule:
 - 1/15/03 - Draft Research Assessment Report and Gap Analysis
 - 3/7/03 - Final Research Assessment Report and Gap Analysis
 - 3/14/03 - Initial Balanced Portfolio

Research Assessment and Gap Analysis (Draft)



Based on the nature of transmission and current activity, we have selected four preliminary research areas in which most projects fall.

Are there research, development, demonstration or commercialization opportunities that can enhance transmission reliability and capability in California?

Public Health & Safety
Are there technologies that can enhance the security, improve the safety and minimize the environmental impacts of transmission?

Optimize Existing System
Are there technologies that can enhance reliability, availability & efficiency of transmission?

Market & System Performance
Are there technologies that can enhance capability through application/integration of market forces?

Major Transmission Additions >50% Capacity
Are there technologies that will provide a quantum leap in transmission capability or simplify adding new lines?

This assessment is the first step in the research plan development process to understand current research being conducted by industry, nonprofit organizations, and government, and to identify where gaps exist.



Our assessment will reach out to:

- Government Agencies and Regulators
- Reliability Organizations
- National Labs
- Academia
- Utilities Equipment Manufacturers
- Industry Organizations

Scenario Analysis

- High Degree of Uncertainty
- Opportunity to Build on DOE Work
- Value of scenarios - stimulate thinking regarding what the future could be and how you can get there
- Assess what critical R&D will not be done by the private-sector and is appropriate for public funding over a range of different possible futures.
- Helps develop contingency strategies for our plan

Scenarios for CEC Transmission Planning



4 Scenarios under development:

- Status Quo Continues
- State-Mandated Solutions
- Regionally-Coordinated Solutions
- Localized Solutions

Characteristics that Define Scenarios

Under Discussion:

- Central Features. Descriptions of how the world would look under each scenario.
- Major External Events. Blackouts, fuel spikes, low-cost fuel cells are developed, etc.
- Supply-Demand Balance.
- Ownership of Transmission Assets.
- Transmission Planning.
- Incentives for Regulated Transmission Investments
- Operation of Transmission System
- Market Design
- Reliability Management

Public Input



- CEC Roundtable - key stakeholders (Jan. 2003)
 - Preview of what will be discussed at an upcoming Public Workshop
 - Reveal possible options for implementation and administration of research program
- Public Workshop (late February)
 - Present Draft ESI R&D Transmission Plan as well contributing R&D research assessment and Gap and Scenario Analysis
 - Incorporate comments
- March 21, 2003 - Target date for Final ESI Transmission R&D Plan
- Summer 2003 - Implementation

Challenges and Issues



Process

New legislation (SB 1038)

- Requires the Energy Commission to award California IOUs up to 10% of the funds transferred to PIER for transmission and distribution R&D
 - The money is available in January 2003
 - Utilities are anxious to understand how the CEC intends to comply with legislation
 - The legislation specifically calls for transmission and distribution R&D
 - Develop a process that will allow a structured discussion of how funds will be allocated in the context of a balanced and focused transmission R&D plan (as well as an overall balanced PIER portfolio)

Challenges and Issues



California Transmission System

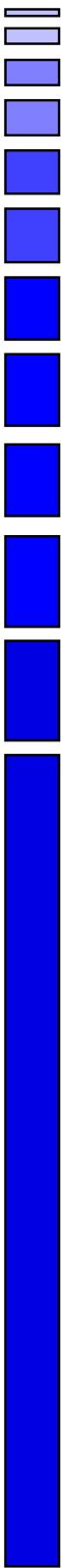
- Uncertainty is causing private-sector investment in R&D to continue to decline
- The transmission grid in California and the West is stressed due to increased demand throughout the region
- Minimal investment in transmission upgrades and/or additions are planned in the near future.
- Without investment in reliability transmission R&D, profound consequences can be expected that will affect the quality of life in California.

Questions for the Committee

- Does the proposed process for developing our transmission plan put us in a good position to develop a robust and focused R&D transmission plan?
- Do you have any suggestions or observations that will add value to the process we propose?
- What do you think will be the greatest challenge?



PIER Real-Time Ratings for Path 15



Contractor: The Valley Group

Contract #700-00-006

Contract Amount: \$369,204

Don Kondoleon - PIER Contract Manager



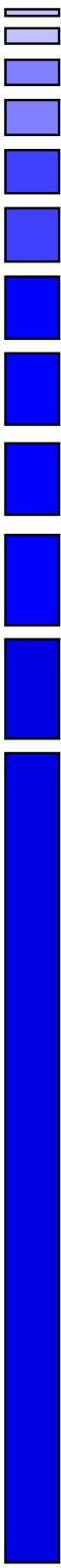
Problem Addressed



- Transmission bottlenecks often deter adequate supply and subsequently increase prices
- Congestion cost for Path 15 in the fourth quarter of 2000 alone was \$169 million



Project Purpose



- Demonstrate the feasibility of implementing real-time transmission line ratings for Path 15, which is one of the most complex gates in the California transmission system



The Research

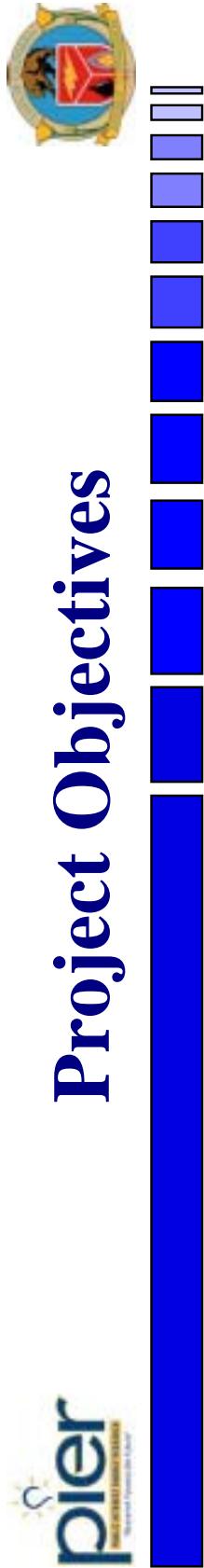


- Investigates the feasibility of providing real-time transmission line ratings by monitoring the conductor tension and environmental factors for a multiple transmission line path

- Investigates the feasibility of providing a calculated real-time rating for the path directly to the system operators

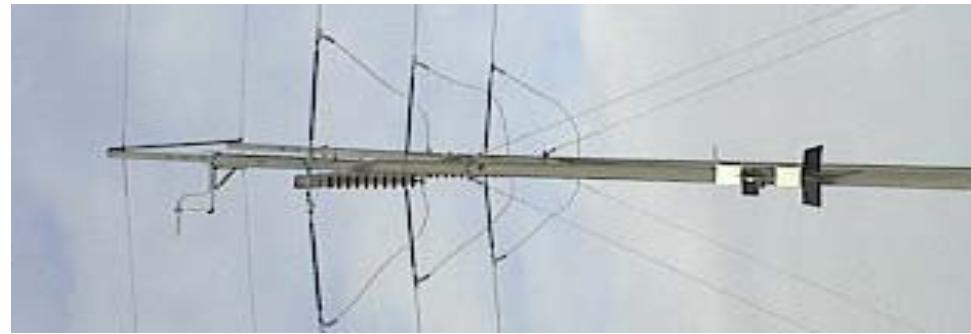
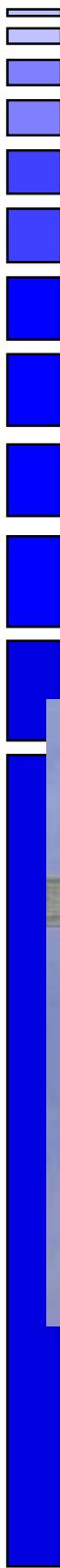


Project Objectives



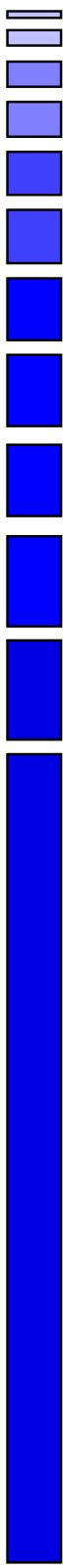
- Increase the power transfer capability through Path 15 by 15-20% on an annual basis
- Decrease utility expenditures by \$1 million per month through decreased transmission congestion on Path 15 during peak periods
- Identify other possible paths in California which could benefit from real-time transmission line ratings

Deployment of Monitoring System





PIER Benefits to California Ratepayers



This project will benefit California's electricity ratepayers by meeting the following PIER goals:

- Improving the reliability and quality of California's electricity by increasing power transfer capability on an annual basis through Path 15
- Improving energy cost/value of California's electricity by reducing electricity expenditures through decreased transmission on Path 15 during peak periods



Pier Making the Market Connection



- Real-time ratings software for Path 15 results have been verified by the grid operators
- Draft report identifies other CA. paths that could benefit from real-time transmission line ratings
- PG&E has purchased and installed additional real time ratings monitors in critically constrained parts of the San Francisco Bay Area
- WAPA and SMUD are working with the CEC to develop a follow-on project to help alleviate voltage constraints in the Sacramento area through the use of real-time ratings

Consortium for Electric Reliability Technology Solutions

Real Time System Monitoring and Control
Activities and Accomplishments and Current Plans for
CERTS/EPRI Electric System Reliability Project

California Energy Commission
Public-Interest Energy Research
Energy Systems Integration Review Meeting

November 21, 2002

Joe Eto

CERTS Program Office

Lawrence Berkeley National Laboratory

<http://certs.lbl.gov>

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Overview of Today's Presentation

- Review overall project and introduce work in real-time system monitoring and control
- Describe 2 CERTS real-time system monitoring and control projects in greater detail
 - VAR Management
 - Synchronized Phasor Measurement Workstation
- Preview upcoming major research activities



PIER Electric System Reliability Project

CERTS/EPRRI initially awarded \$7.2 Million/2 year project
\$3 Million/1 year contract amendment approved in Fall '02

Four research areas (\$4.8M–1 styr/\$2.4M–2nd yr/\$3.0M–3rd yr)

Grid of the Future (\$150k/0k/0k)

DER Integration (\$500k/250k/1050k)

Reliability and Markets (\$450k/0k/950k)

Real-Time System Monitoring and Control (\$3700k/2150k/1000k)

= today's focus

Project started August, 2000

Joe Eto is LBNL/CERTS contract manager

Carlos Martinez is CERTS technical project manager for RTSMC
Don Kondoleon is CEC project manager

(now coordinating with Mark Rawson, Ron Hofmann, Linda Kelly)
Laurie ten Hope is CEC PIER ESI program manager

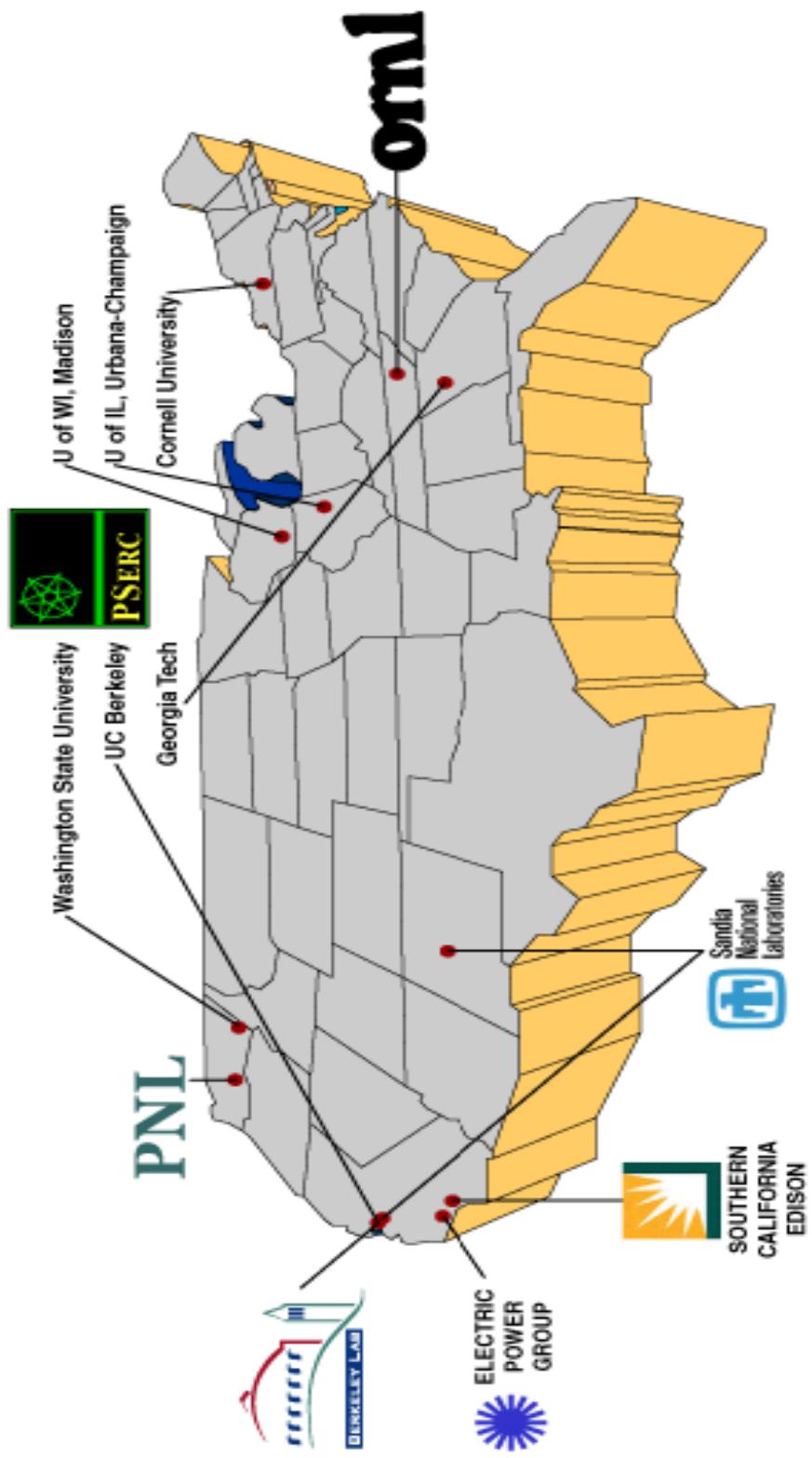
Lisa Szot and David Hawkins are CAISO technical coordinators

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CERTS Research Performers



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Real Time Grid Reliability Management

- Managing electricity operations has always been based on planning for un-expected events
 - Reliability planning involves ensuring the system can withstand loss of one or more transmission lines or generators
- Reliability management involves maintaining system voltages and frequency within acceptable boundaries
 - This task has always been technically challenging
 - And, today, has been made much more difficult due to electricity restructuring
- CERTS has developed (DOE) and is demonstrating (CEC) two tools for system operators that reduce response times
 - Laying the groundwork for technologies needed for future automatic grid control

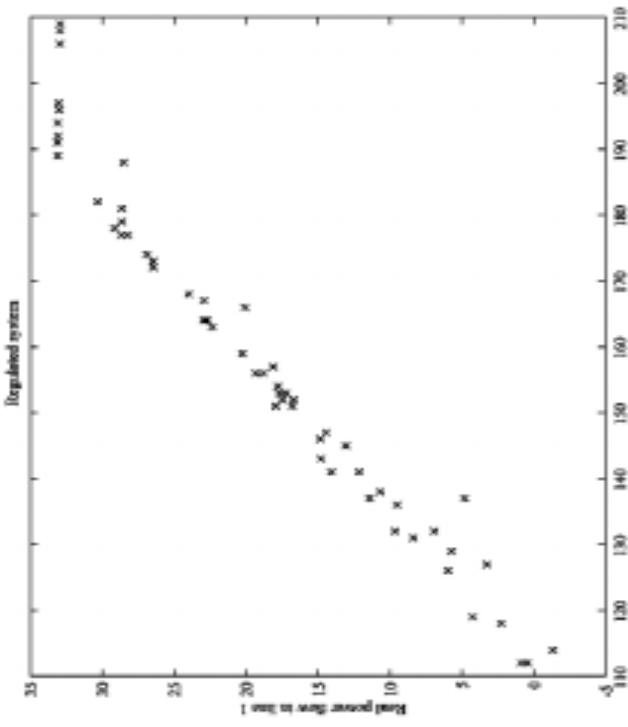


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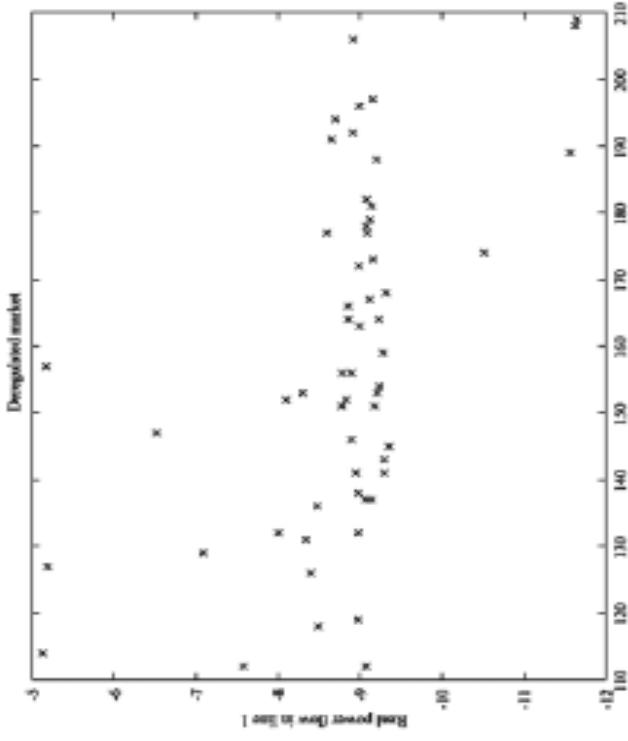
Can Operators Predict Market Behavior?

Results of Market Simulations Performed by PSERC

Vertically Integrated System



Restructured Market



- Strong correlation between power flow and demand
- Economic dispatch

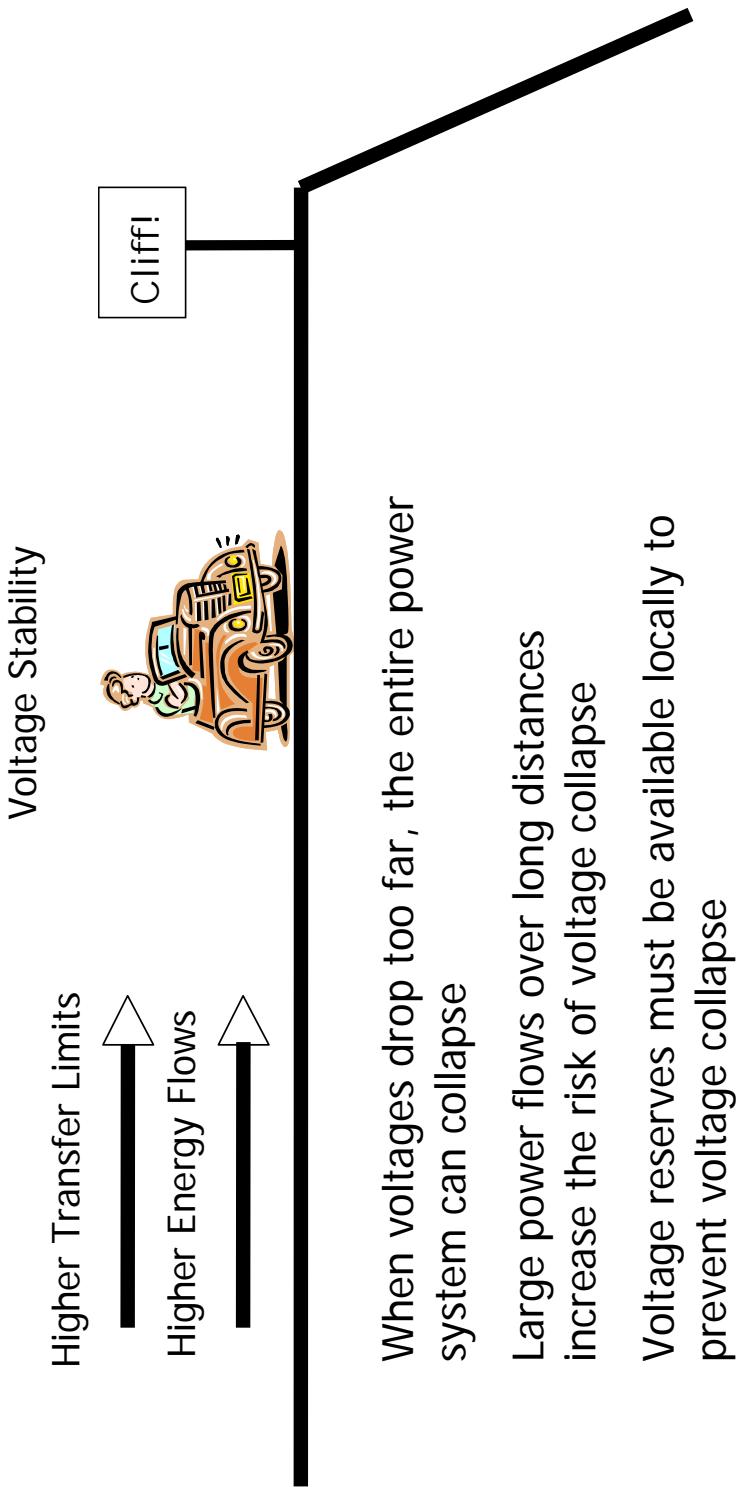
- Market-based dispatch
- Poor correlation between power flow and demand



CONSORTIUM FOR ELECTRIC RELIABILITY TECHNOLOGY SOLUTIONS



Grid Reliability Depends on Maintaining Adequate Voltages Throughout System



CERTS Voltage Management Tool

- Presents real-time information on system conditions in readily understood graphic-visuals that facilitate action
 - Key problem for operators today is data overload
- Reduces time needed to initiate corrective actions from 30-60 minutes to less than 5 minutes
 - Allows system operators to identify, assess, and analyze corrective actions for emerging voltage problems
 - Integrates formerly separate analysis steps (requiring separate staff) seamlessly on a single screen
- Could have prevented August 10, 1996 blackout of west coast
 - Demonstration installed at California ISO in Fall 2001

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Operators Currently Have Too Much Data, But Not Enough Information

15227		1/ 5		08/17/98 12:48:12											
■ REFRESH DATA		TODAY'S 10-MINUTE GENERATION CONTROL PERFORMANCE DATA													
■ CRRTR+95%		TIME		A1	A2	A3	SYSTM	AGC REQUEST	-CONTL REQUEST	STEAM-REQUEST	HYDRO REQUEST	RSPNSE	RSPNSE	RSPNSE	RSPNSE
CRRTR+95%	%	95%	95%	46MW	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
12:40	89.5	85.5	85.5	68	-1	15	18	8	0	0	0	0	0	0	0
12:30	89.3	85.3	85.3	68	-3	9	-9	-1	0	0	0	0	0	0	0
12:20	89.2	85.2	85.1	69	-6	16	28	26	0	0	0	0	0	0	0
12:10	89.0	84.9	84.9	69	-27	56	101	63	0	0	0	0	0	0	0
12:00	88.9	86.1	86.1	69	116	-306	37	17	0	0	0	0	0	0	0
11:50	88.7	87.3	87.3	67	310	-727	-5	1	0	0	0	0	0	0	0
11:40	90.0	88.6	88.6	58	248	-454	0	0	0	0	0	0	0	0	0
11:30	91.3	89.9	89.9	51	159	-354	0	0	0	0	0	0	0	0	0
11:20	92.6	91.2	91.2	48	200	-412	-14	0	0	0	0	0	0	0	0
11:10	94.0	94.0	92.5	42	163	-316	0	0	0	0	0	0	0	0	0
11:00	95.5	93.9	93.9	37	63	-121	-17	37	0	0	0	0	0	0	0
10:50	96.9	95.4	95.4	37	49	-82	-1	-4	0	0	0	0	0	0	0
10:40	96.9	95.3	95.3	37	37	-61	-1	1	0	0	0	0	0	0	0
10:30	98.4	95.2	95.2	36	42	-60	-1	1	0	0	0	0	0	0	0
10:20	98.4	95.2	95.2	36	30	-40	-22	-18	0	0	0	0	0	0	0
10:10	98.4	95.1	95.1	36	18	-9	-31	-4	0	0	0	0	0	0	0
10:00	98.3	95.0	95.0	36	-2	14	6	4	0	0	0	0	0	0	0
9:50	98.3	94.9	94.9	36	2	14	6	4	0	0	0	0	0	0	0
9:40	98.3	94.8	94.8	37	8	7	-6	-3	0	0	0	0	0	0	0
9:30	98.2	94.7	94.7	37	-16	13	1	1	0	0	0	0	0	0	0
9:20	98.2	94.6	94.6	37	-1	15	34	28	0	0	0	0	0	0	0
9:10	98.2	94.5	94.5	37	-16	23	32	19	0	0	0	0	0	0	0
9:00	98.1	94.4	94.4	37	-15	36	31	23	0	0	0	0	0	0	0
8:50	98.1	94.3	94.3	37	-6	-6	-5	-3	0	0	0	0	0	0	0
8:40	98.1	94.2	94.2	36	16	-14	6	-1	0	0	0	0	0	0	0
8:30	98.0	94.1	94.1	36	43	-68	0	0	0	0	0	0	0	0	0
8:20	98.0	94.0	94.0	36	48	-79	-32	-26	0	0	0	0	0	0	0
8:10	98.0	93.9	93.9	35	59	-80	-38	-24	0	0	0	0	0	0	0
8:00	97.9	97.9	97.9	33	-6	-6	-5	-3	70	68	68	68	68	68	68
7:50	97.9	97.9	97.9	33	-8	14	44	33	-1	7	7	7	7	7	7

- PERFORMANCE DATA FOR DAY >23<
 10-MINUTE PREDICTIVE REGULATION
- >N< DUMP DATA TO ASCII FILES GCCALS1
 & GCCALS2 FOR DAY >99<
 (O=TODAY: 99=ALL DAYS) GO

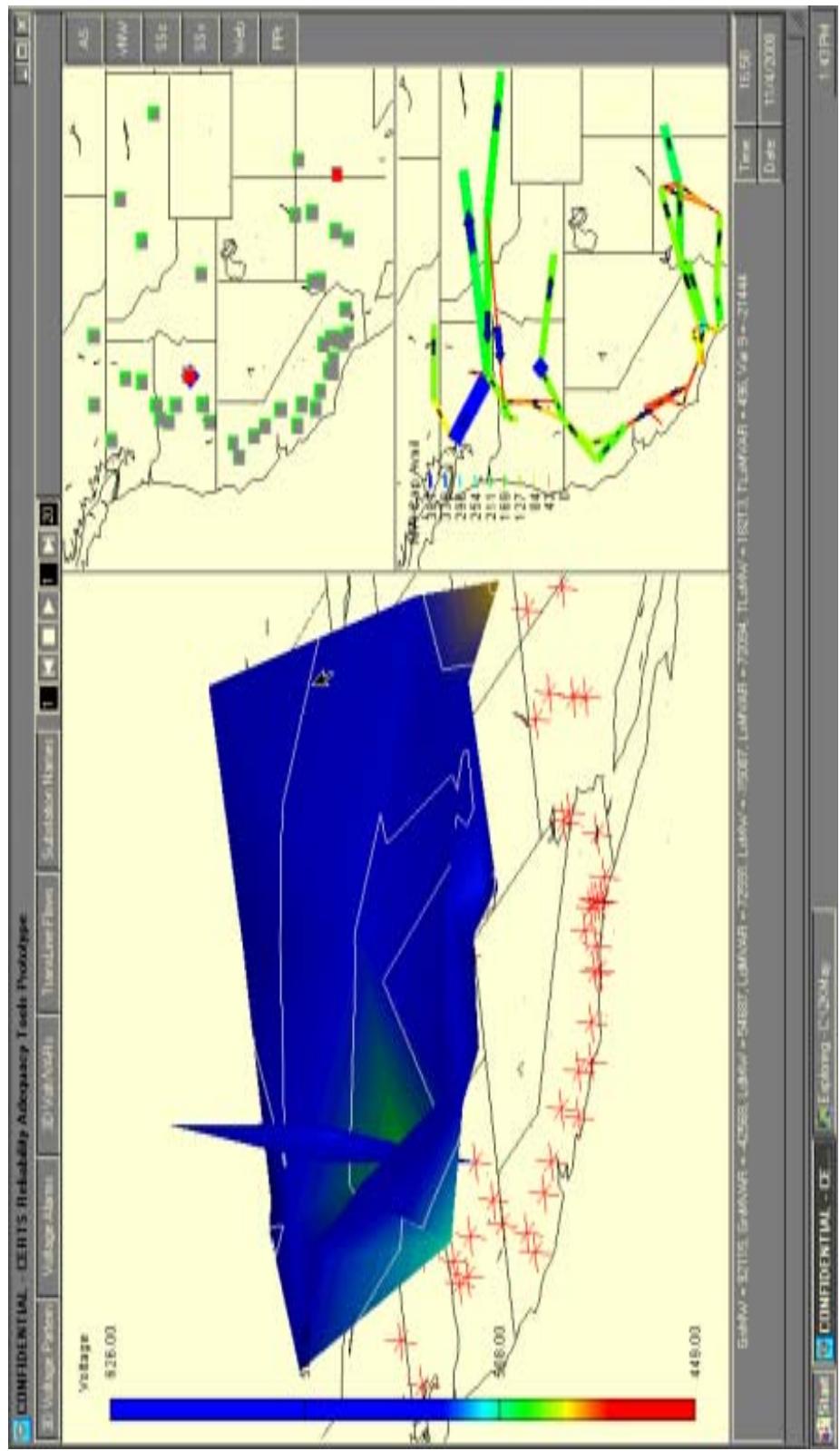
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CAISO-CERTS Voltage Management Tool

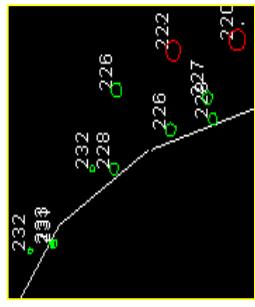
Turns Data Into Information



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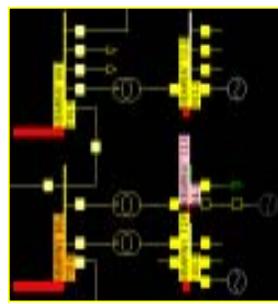
CAISO-CERTS VAR-Management Summary



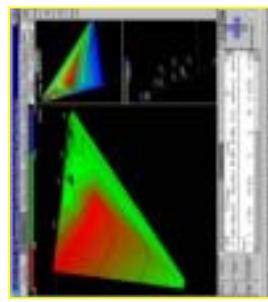
Alarming and Monitoring



Sensitivities and Collapse Distances



WSCC Compliance and Corrective Actions

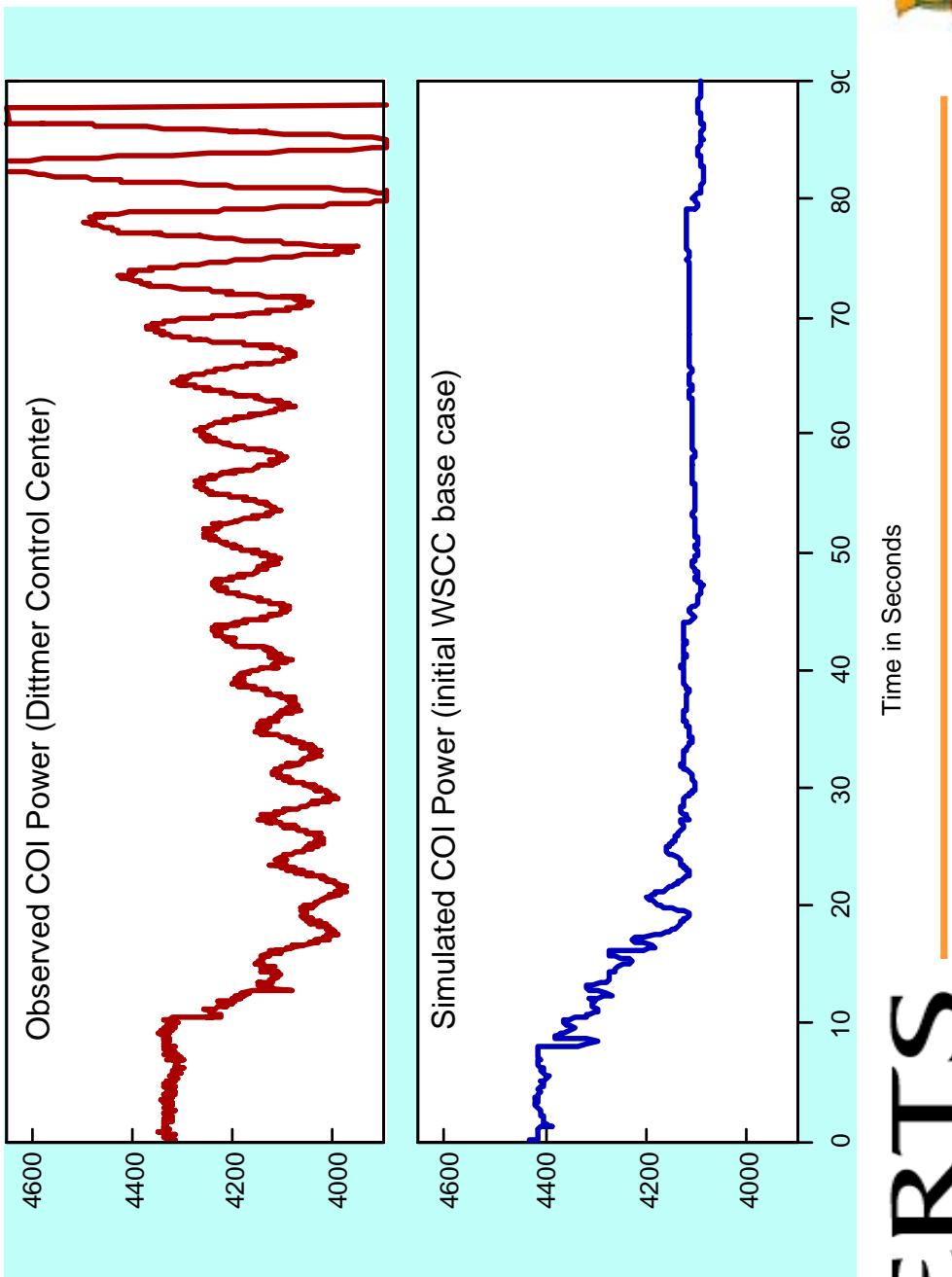


Historical Tracking and Replay



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Modeling failure for WSCC breakup of August 10, 1996 (MW on California-Oregon Interconnection)



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Synchronized Phasor Measurements

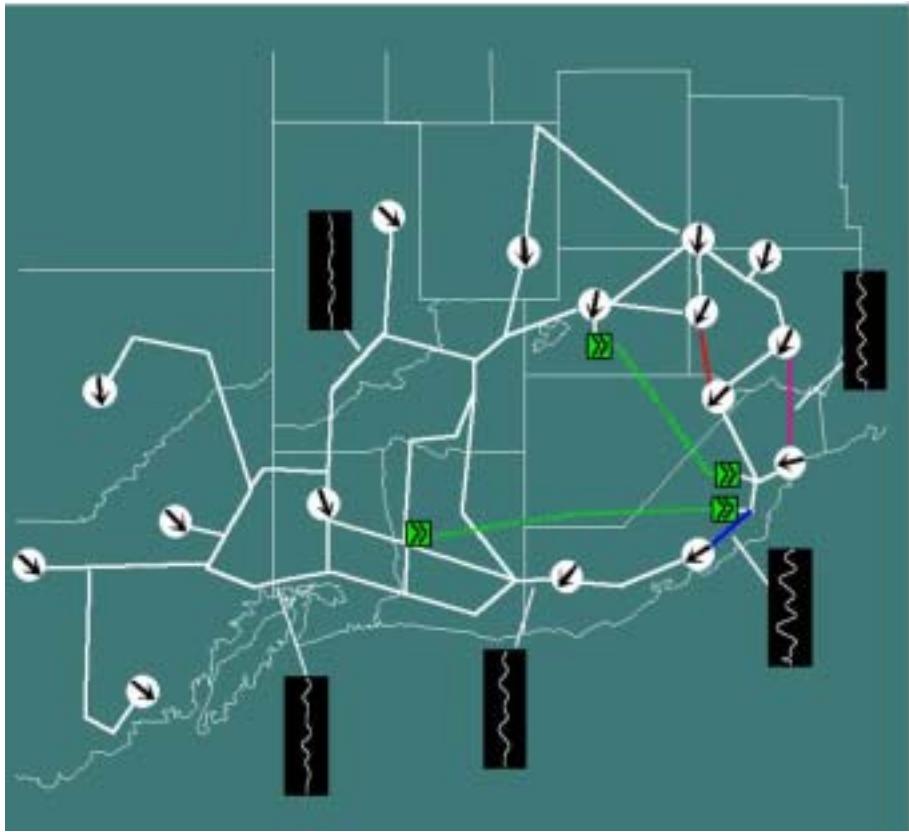
Improved Real-time Information on System Conditions

- DOE/BPA/WAPA/EPRI Wide Area Measurement System, in mid 1990s, installed 32 demonstration Phasor Measurement Units (PMU) throughout West
 - Direct GPS time-stamped observations of electrical waveform
 - Current utility monitoring systems sample once every 4 seconds; PMUs sample 100 of times *per second*
- Permitted detailed post-analysis of August 10, 1996 blackout in West
- CERTS installed a post-disturbance assessment workstation at California ISO in Summer 2001; just completed high-speed link coordinated through WECC
- Through these installations, CERTS is exploring new approaches for improving real-time operations



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CAISO Dispatchers Dynamics Monitoring Using Phasor Measurements



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Future CERTS PIER ESI Research Activities

- In conjunction with CAISO
- Full integration of CERTS tools into CAISO operations
- New tools for loop flow management
- First ever prototype for application of phasor data to support real-time operations
- Electricity market simulation for operator training
- R&D plan for demand response
- Other PIER ESI activities
 - Transfer NY real time pricing experience to CA
 - Controlled lab demonstration of CERTS Microgrid concept

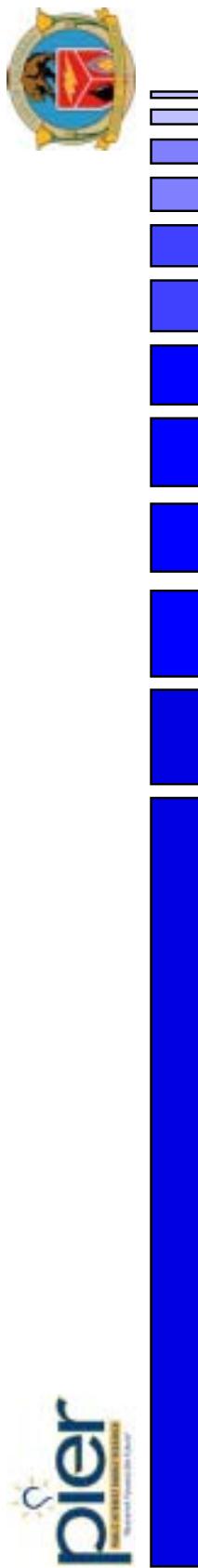


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Summary

- Electricity restructuring has increased the difficulty of managing the reliability of electric power systems and at the same time dramatically reduced private investment in needed public interest R&D on electricity reliability
- Through PIER, CERTS is working in close collaboration with CAISO to prototype needed tools to improve reliable grid operations
- The PIER ESI project directly leverages and is conducted in close coordination with DOE's Transmission Reliability program
- Development and demonstration of these tools is a necessary first step in the evolution toward a more resilient electricity system





Material Integrity Solutions, Inc.

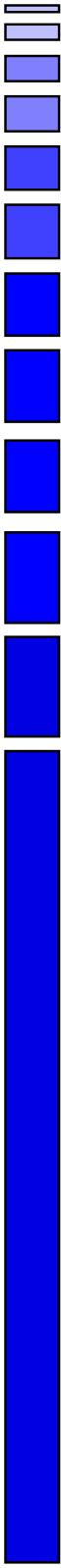
Sagging Line Mitigator Project

Contract # 500-98-042

Contract Amount: \$900,000

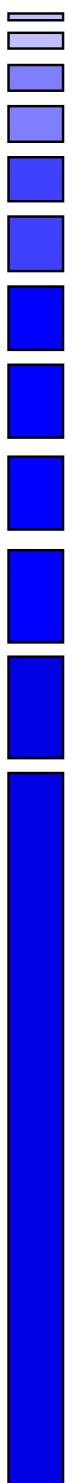
David A. Chambers: PIER Contract Manager

Problem Addressed



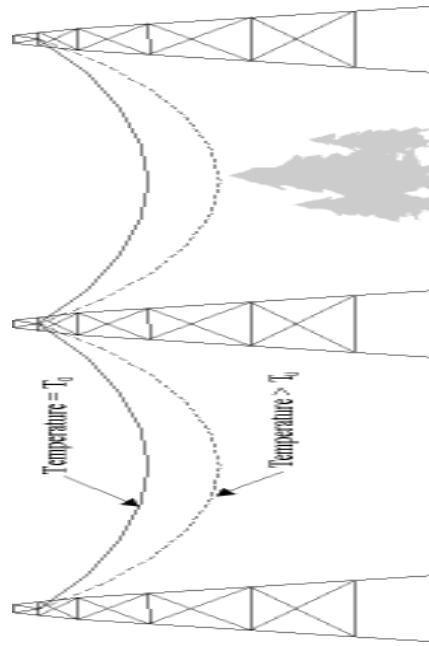
- “Power Outages Cost \$119 Billion Per Year”(nationwide)-*Air Conditioning Heating Refrigeration The News (August 27, 2001)*

Pier Problem Addressed, Continued



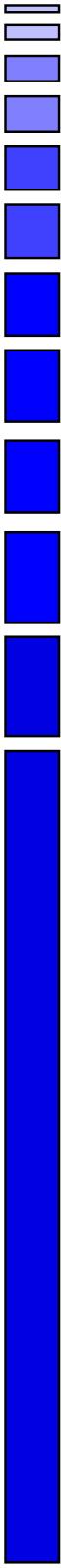
- One of the major causes of this problem is sagging power transmission lines and restricted power capacity transmission

- As power transmission lines heat-up (due to ambient temperature and increasing electric current) they begin to sag, and could cause fires.



By law the transmission lines have a minimum line to ground clearance, thus artificially reducing power transmission capacity.

Project Purpose



- Automatically and mechanically pull in the slack of sagging power lines.
- Compensate for line sag caused when ambient temperature increases.

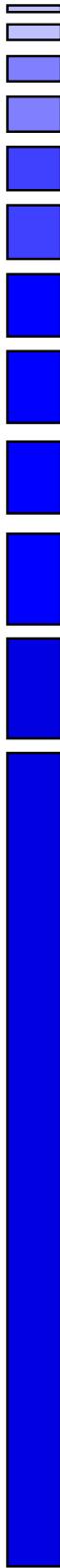


The Research



- The research, development and demonstration of a Sagging Line Mitigator (SLiM) device to compensate for line sag caused when ambient temperature increases.
- The SLiM device to be able to vary its range of motion to accommodate different line sag requirements.
- Serviceable Lifetime: Device should match industry standard for transmission line hardware.
A target life span of 30-50 years.

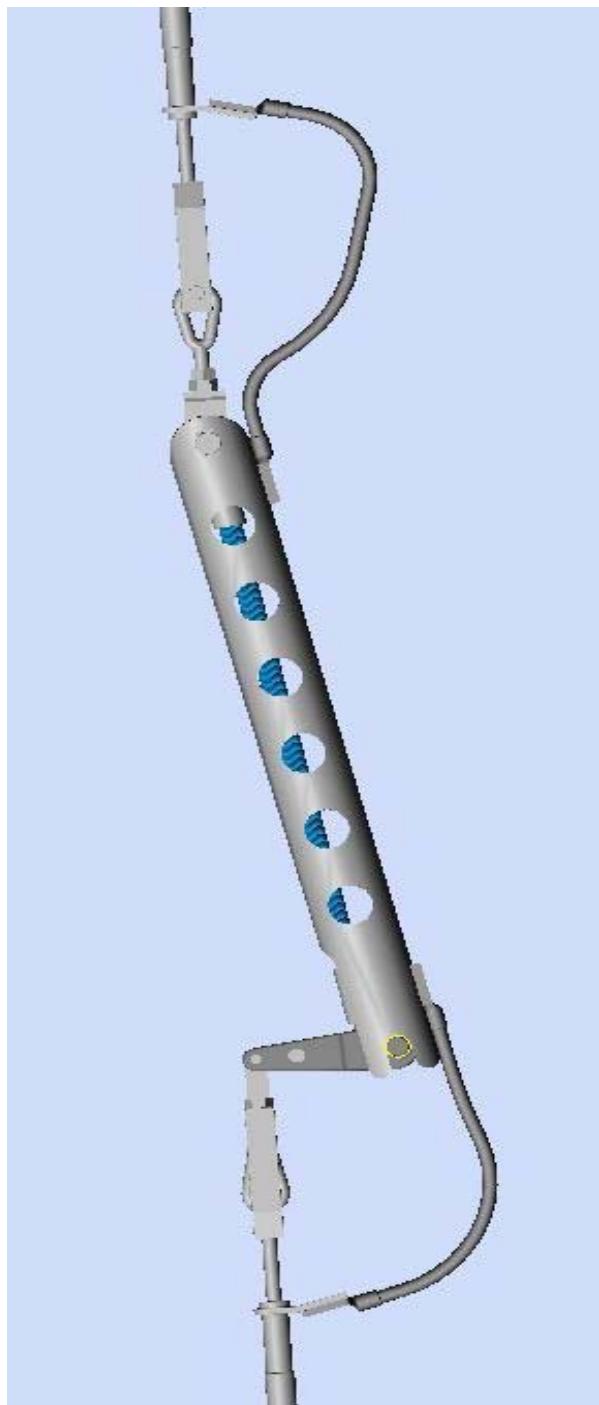
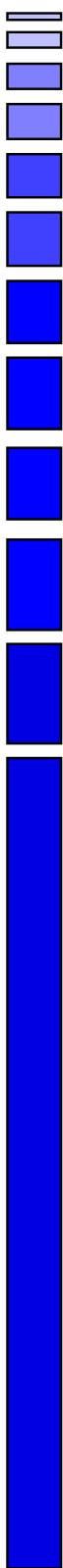
Project Objectives



The Objectives of this project are to:

- Develop an automatic device.
- Develop a self-adjusting mitigating device such that the same change in ambient temperature that causes the line to sag will concomitantly cause the device to act to mitigate the line sag.
- Develop an essentially maintenance free device.

SLiM Device Rendering



Benefits to California Ratepayers

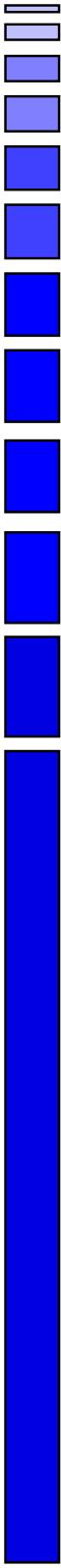


- This project will benefit California electricity ratepayers by meeting the following PIER goals:
 - Improving Reliability and Quality enabled by reducing the curtailment of electric deliveries due to line capacity constraints (brown/black-outs).
 - Improving Safety enabled by reducing the risk of electrocution and vegetation fires caused by sagging lines.





Making the Market Connection



- Successful full-scale field functionality tests were performed at Pacific Gas & Electric's Livermore facility in July 2002.
- The Electric Power Research Institute determined this project has value to its members and initiated field tests on the device.
- Pacific Gas & Electric, San Diego Gas & Electric and Los Angeles Department of Water and Power Engineering Supervisors stated they want SLiM in their transmission toolbox.



Strategic Systems & Enabling Technologies Research Program

Technical Review
November 21, 2002

Laurie ten Hope, Program Lead
Energy Systems Integration Research Program
Public Interest Energy Research Program
California Energy Commission



Scope:

- Develop long term, crosscutting and innovative advancements in science and technology.
 - Reduce Seismic Vulnerability
 - Market Analysis
 - Storage Advancements
 - Communication & Control Technologies
 - Regional Solutions

Current Projects



- PG&E - Electric System Seismic Safety and Reliability Project; \$4.5 million
- EPRI TC - Seismic Qualification of Substation Equipment Using IEEE 693-1 997(Recommended Practice for Seismic Design of Substations); \$20K
- UC Center for the Study of Energy Markets - Market Analysis; \$2.05 million
- AFS Trinity Power Corporation: Flywheel Power System Development; \$1.06 million
- AESC - Intelligent Software Agents for Control and Scheduling of Distributed Energy Resources; \$500K
- NPT - Regional Solutions Pilot; \$616K

Featured Project



- Intelligent Software Agents for Control and Scheduling of Distributed Energy Resources
- Contractor: Alternative Energy Systems Consulting
- Presenter: Jamie Patterson



Alternative Energy Systems Consulting

Intelligent Software Agents for Control
and Scheduling of Distributed Energy
Resources

Contract # 500-01-016

Contract Amount: \$499,970

Jamie Patterson - PIER Contract Manager

Problem Addressed

- The electric system is quickly evolving into a large interconnected network of distributed resources with diverse ownership.
- New technology is needed to facilitate electronic commerce (i.e., buying and selling energy, monitoring supply and demand, system monitoring and maintenance, etc.) within the electricity system

Project Purpose

- This is a follow on contract to #500-98-040 to develop an automated solution to bidding and dispatching distributed energy resources in a cost effective manner.
- Intelligent agents using sophisticated algorithms can facilitate the coordinated scheduling of multiple distributed energy resource assets. This decentralized decision making will reduce the expertise needed to own and operate distributed energy resources, allowing greater participation by owners of distributed energy resources in California's competitive energy industry.

The Research



- The key to developing an automatic solution is to develop Intelligent Software Agents that monitor price, weather, future local energy needs, and costs to make distributed decisions.
- Intelligent agents have the ability to monitor their own execution environment, communicate with other agents or the user and maintain some representation of their own state. An intelligent agent is able to complete its task on its own.
- The challenge is to be able to do this in real time, inexpensively.

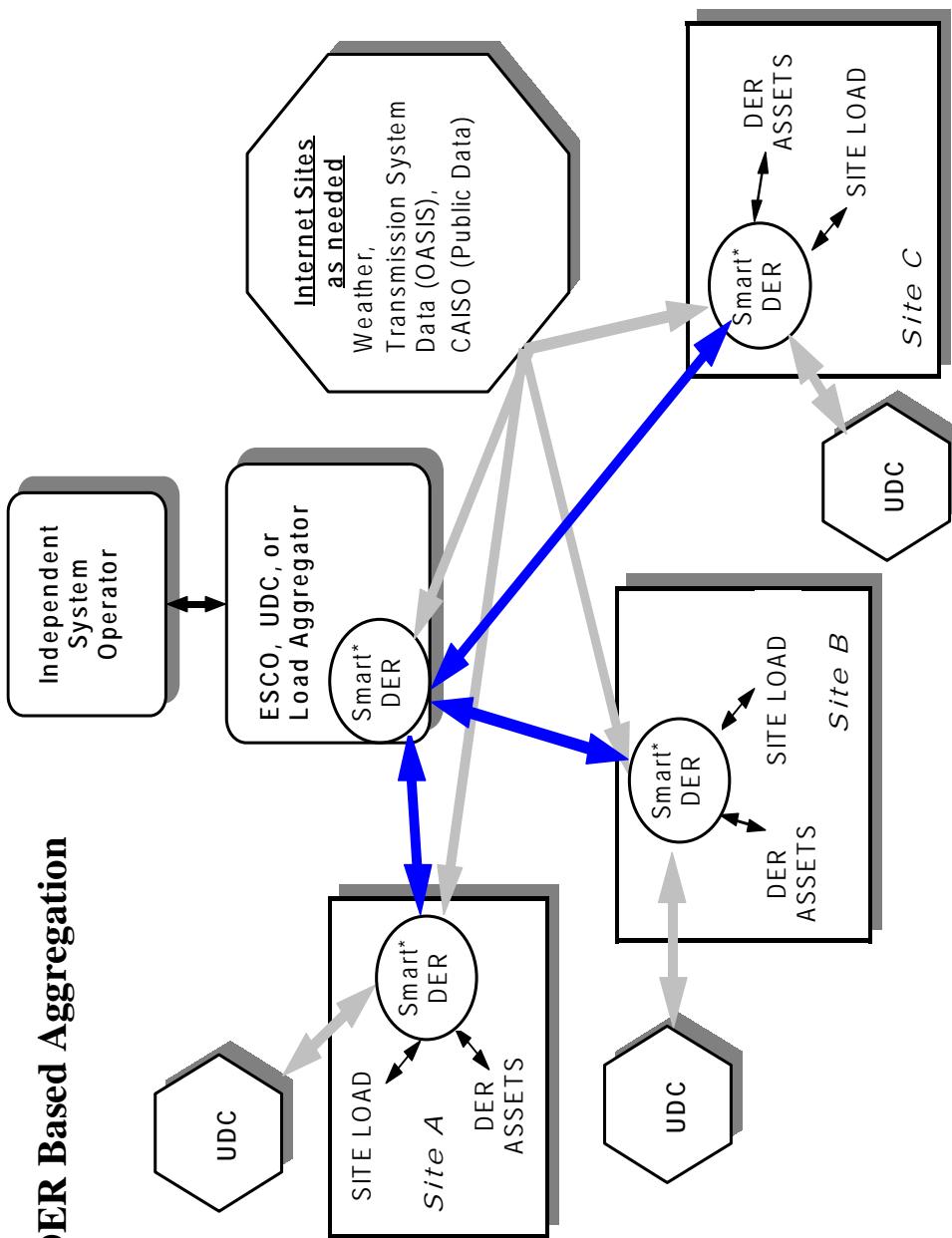
Project Objectives

The Objectives of this project are to:

- Revise the functionality to reflect changes in the California Energy Marketplace.
- Get a partner to integrate the product into their devices for a field test.
- Refine the interface requirements to enable operation.
- Complete a feasibility test scheduling and controlling actual DER units.

Sample Agent-based Market Solution

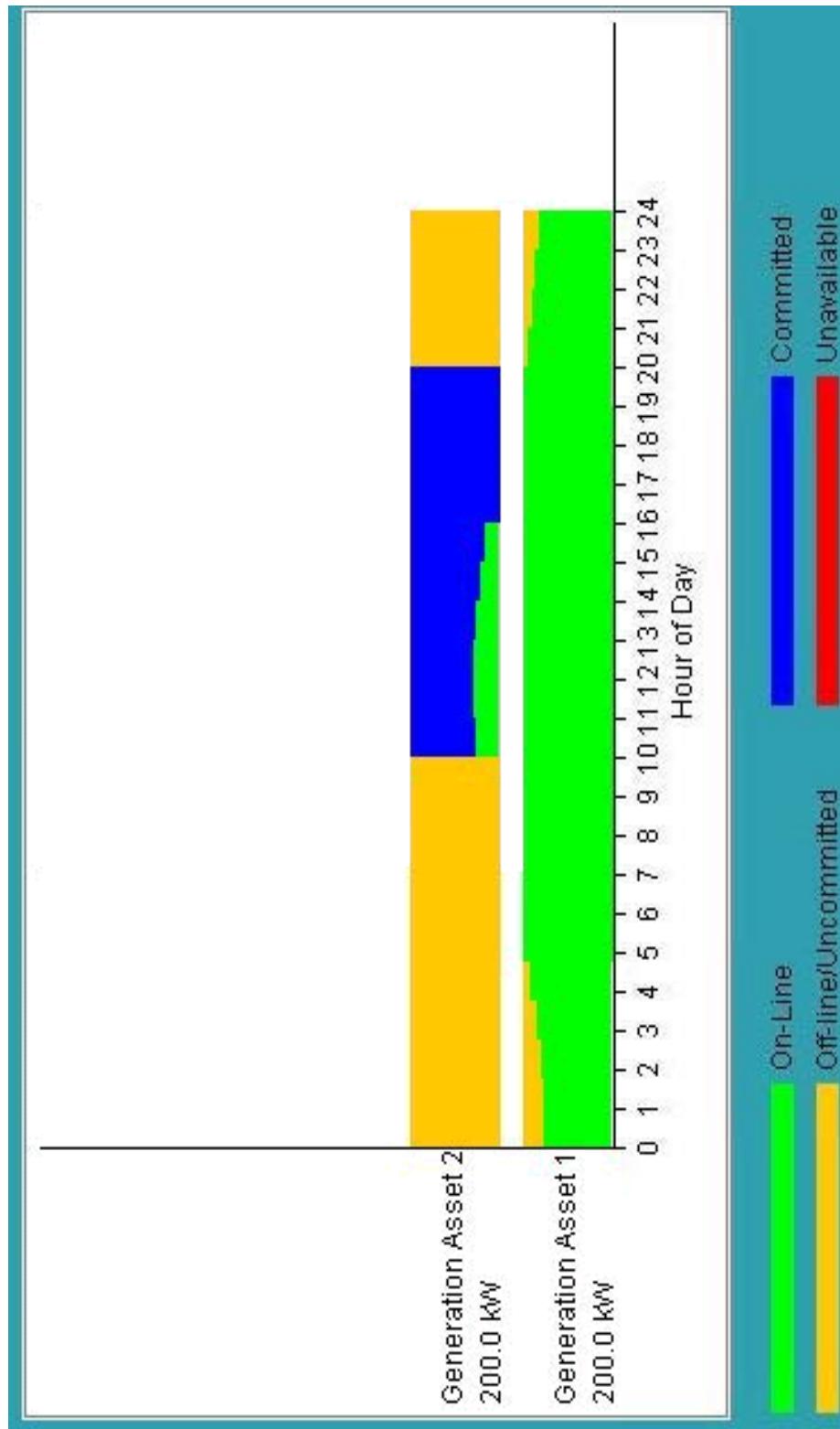
Smart* DER Based Aggregation



Smart*DER Schedule Generation



*Smart*DER Operating Schedule -
Excess Capacity Bid into AS Market (blue)*



Benefits to California Ratepayers



This project will benefit California electricity ratepayers by meeting the following PIER goals:

- Improves the reliability and quality of California's energy system.
 - Enables the use of dispersed generation.
 - Enables rapid dispatch of generation and load reduction.
- Improves the energy cost and value of California's electricity.
 - Optimizes participation and competition in the electricity market, leading to lower prices.

Making the Market Connection



- Changed behavior of the ISO to post data in a consistent manner. Prior to this project there was no requirement for consistent posting of market information.

- These companies have expressed interest in using agents in conjunction with their products to schedule DER:
 - Engage Energy
 - 6th Dimension
 - Enflex
 - Connected Energy
 - Encorp

Questions for Committee



- We're interested in encouraging research for enabling technologies, useful across many applications.
- What enabling technologies would best address the overall PIER mission?
- Should ESI be less application driven and pursue more basic research? If so, how would you advise pursuing longer term, higher risk research?



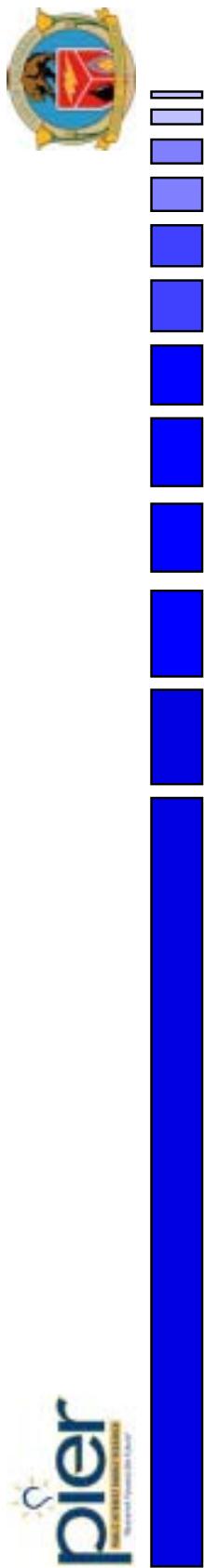
Wrap Up

Questions



■ Questions for the Committee:

- Are we focused enough on *highest* priorities?
Are we spread too thin? Should we “triage” further?
- Are we missing major opportunities?
- Are we positioned to address our challenges?
- Are we selecting the right projects, right collaborators and right researchers?
- What’s the right allocation to T&D, given all the PIER research needs?



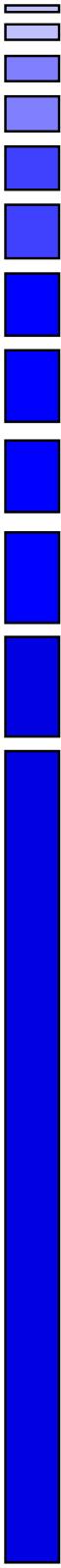
Reflective Energies Development of Interconnection Standards and Case Studies (FOCUS II)

Contract # 500-01-013

Contract Amount: \$1,501,268

Dave Michel - PIER Contract Manager

Problem Addressed



- DG is being installed without adequately understanding the effects it has on the grid
- Lack of consistent interconnection rules, fees, & review time resulted in high cost and lengthy delays



Project Purpose



Simplify CA's DG interconnection process which enables safe, timely & cost-effective installation of new DG into the grid



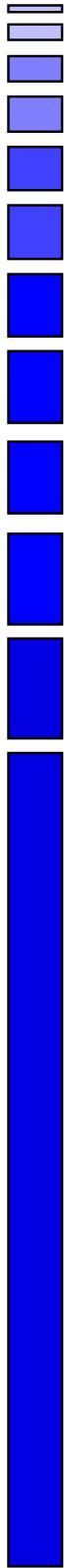
The Research



- Resolve technical safety issues
 - e.g.: “Islanding”, flicker, reactive power flow, harmonic power flow
- Establish technology & size neutral review process
- Identify testing & certification requirements



Project Objectives



Technical Objectives

- Characterize electrical Power Quality effects on grid
- Evaluate whether the interconnect process improved
- Increase number of applications eligible for “simplified interconnection” and thus improve cost effectiveness

Economic Objectives

- Reduce interconnection cost by
 - 30% for units <1MW
 - 15% for unit s ≥1MW
- Reduce total project costs by >20% for projects <1MW





Renewable energy technologies such as photovoltaics are one example of distributed generation benefiting from this research.





Benefits to CA's Ratepayers



This project will benefit California electricity ratepayers by meeting the following PIER goals:

- Improving Reliability/Quality of CA's Electricity
- Improving Energy Cost/Value of CA's Electricity
- Improving Safety of CA's Electricity



Pier Making the Market Connection



■ Rule 21 Certifications:

- Capstone Micro-turbine Generators 330 & 60 : approved, Nov. 2001
- Plug Power Fuel Cell SU1PCM-059622: approved, Nov. 2001

■ Municipal Utilities are adopting Rule 21

- City of Riverside adopted in June 2002
 - LADWP & SMUD: also being taken to their Boards
- ## ■ DOE/NREL outreach successful
- Expect NREL to partner in DG Monitoring Case Studies



New Power Technologies

Contract # 500-01-039
Contract Amount: \$616,689

Linda Kelly - PIER Contract Manager

Problem Addressed



It has been asserted in many forums that small strategically located DER projects, aside from providing benefits to the customer who builds the project, have the potential to improve the operational reliability and quality of both the Transmission & Distribution (T&D) network serving all customers. The problem is:

- How do you substantiate these benefits without a dynamic methodology that can measure the impacts of an extensive portfolio of DER projects down to voltage levels at which these resources will be interconnected.

Project Purpose



This project will:

- Demonstrate a new and unique methodology which will identify, from transmission down to the primary distribution level, the impacts and benefits of multiple DER installations on reliability and power quality.
- Value these network benefits in engineering and economic terms;
- Suggest financial and non-financial incentives to facilitate development of beneficial DER projects

The Research



- Developing a single network that includes both transmission and distribution characterizations.
- Utilizing a dynamic optimization tool to identify additions of embedded generation, reactive capacity and demand management to improve the integrated T&D network performance.
- Identifying locations and attributes of the most beneficial DER projects (operating profiles, real and/or reactive power capacities, interconnection network operation and avoid network improvements), as well as quantifying their value in both engineering and financial terms.

Project Objectives



The Objectives of this project are to:

- Prove that it is feasible to integrate transmission and distribution characteristics into a single power flow model
- Demonstrate a methodology that can identify specific locations where DER projects provide T&D system benefits that are additive to the project developers benefits.
- Quantify the engineering and financial benefits of these specific DER projects.

Benefits to CA's Ratepayers



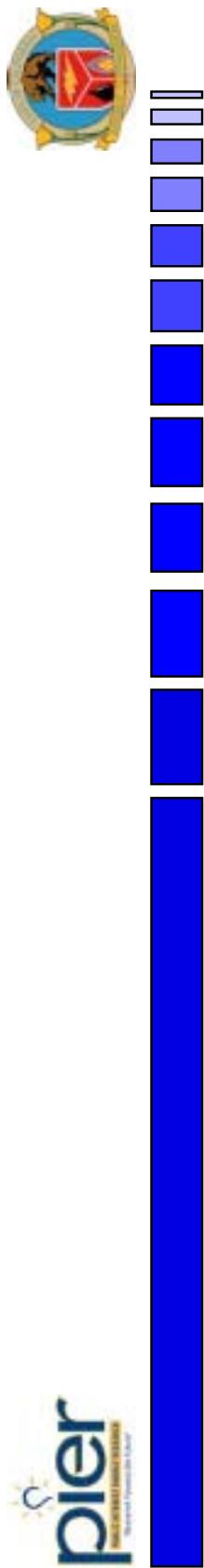
This project will benefit California electricity ratepayers by meeting the following PIER goals:

- Improves reliability/quality of California's electricity system by identifying where distributed energy resources can be located to help alleviate transmission and distribution capacity and congestion problems in the state.
- Supports the goal of providing more choices to California consumers by helping to overcome the barriers to the deployment of distributed energy resources.

Making the Market Connection



- Silicon Valley Power is a partner and is ready to apply the findings to their system.



Distributed Utility Integration Test (DUIT)

Contract # 500-01-033
Contract Amount: \$2,049,850

Dave Michel - PIER Contract Manager

Problem Addressed

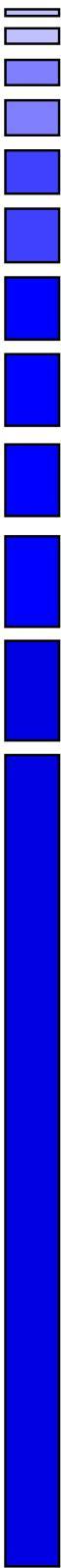


DG is being installed without enough operating experience

- How will a large penetration of Distributed Energy Resources (DER) impact the electrical distribution system?
- How will multiple DER interact with each other in close proximity? (e.g. on same feeder)



Project Purpose



Determine the impacts of large penetrations of DER onto distribution feeders through laboratory testing of commercially available DER hardware and distribution equipment

The Research



Builds on work started by DOE

- Simulate different distribution feeder configurations with varying DER penetrations and varying DER technologies
- Evaluate the electrical interactions during normal and abnormal operations of DER devices and the feeder
- Determine voltage stability, safety and PQ implications on the feeder, feeder loads and DER devices
- Validate penetration limits and/or screens established in Rule 21 and IEEE P1547
- Develop recommendations for improvements to interconnection equipment, rules and standards

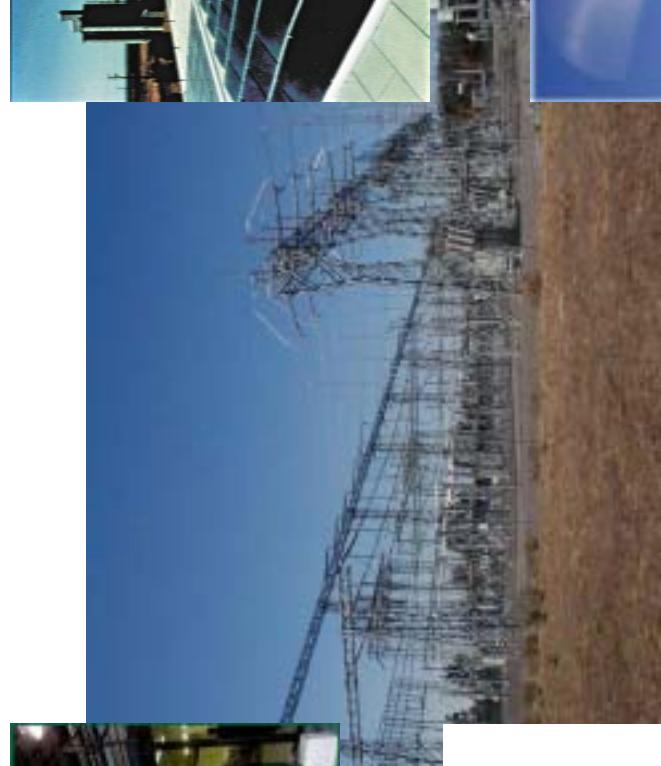
Project Objectives



- Prove the feasibility of integrating diverse DER into the distribution system
- Provide a testing ground for observing and measuring the interaction of DER on the distribution system

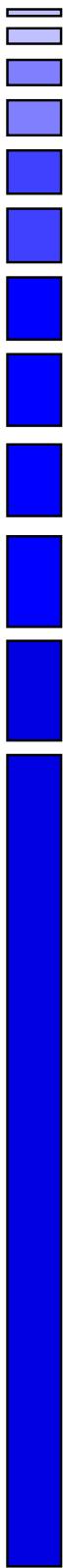


DUIT: Getting on the Grid





Benefits to CA's Ratepayers



This project will benefit California electricity ratepayers by meeting the following PIER goals:

- Improving Reliability/Quality of California's Electricity
- Improving the Safety of California's Electricity by determining the impact of large penetrations of DER into the distribution system



Making the Market Connection



■ Research will address:

- Key issues identified in CEC's DER Strategic Plan and ESI's Research Plan**
- Concerns raised by utility protection engineers**
- Better understanding of appropriateness of limits established in Rule 21 and IEEE P1547**





Microgrid Concept Development and Laboratory Testing

Consortium for Electric Reliability

Technology Solutions

Contract No. 150-99-003

Project Amount: \$1,000,000

Mark Rawson: PIER Project Manager



Problem Addressed



- T&D unlikely to reliably deliver needed supply increases
- DER promising option but grid impact from large penetrations unknown
- Present distribution design & operation philosophy prevents benefits of DER from being realized
 - Radial system – one-way power flow limitations
 - Utility solution is to drop all DER during disturbances
 - Prevents reliability through standby power and grid support
 - Prevents local power quality improvement
 - Limits attainable energy cost reductions (Btus and e⁻)

Project Purpose



- Initiate development and testing of CERT's MicroGrid concept in laboratory setting
 - Determine system design and specifications
 - Entail proof of concept testing for hardware and software
 - Determine protection, control, DER and load integration issues
 - Determine operation optimization strategies for real-world use
- Present work will result in preliminary component testing, system and test design, and laboratory selection RFP

The Research



■ Concept:

Clusters of generators, storage and loads operated as a single controllable system to support transmission reliability that economically provides power and heat to its customers. Can be operated synchronized to grid or as an island.

■ Testing concept to:

- Support large-scale penetration of DER in grid
- Improve cost and reliability for customer
- Improve T&D system reliability

Project Objectives

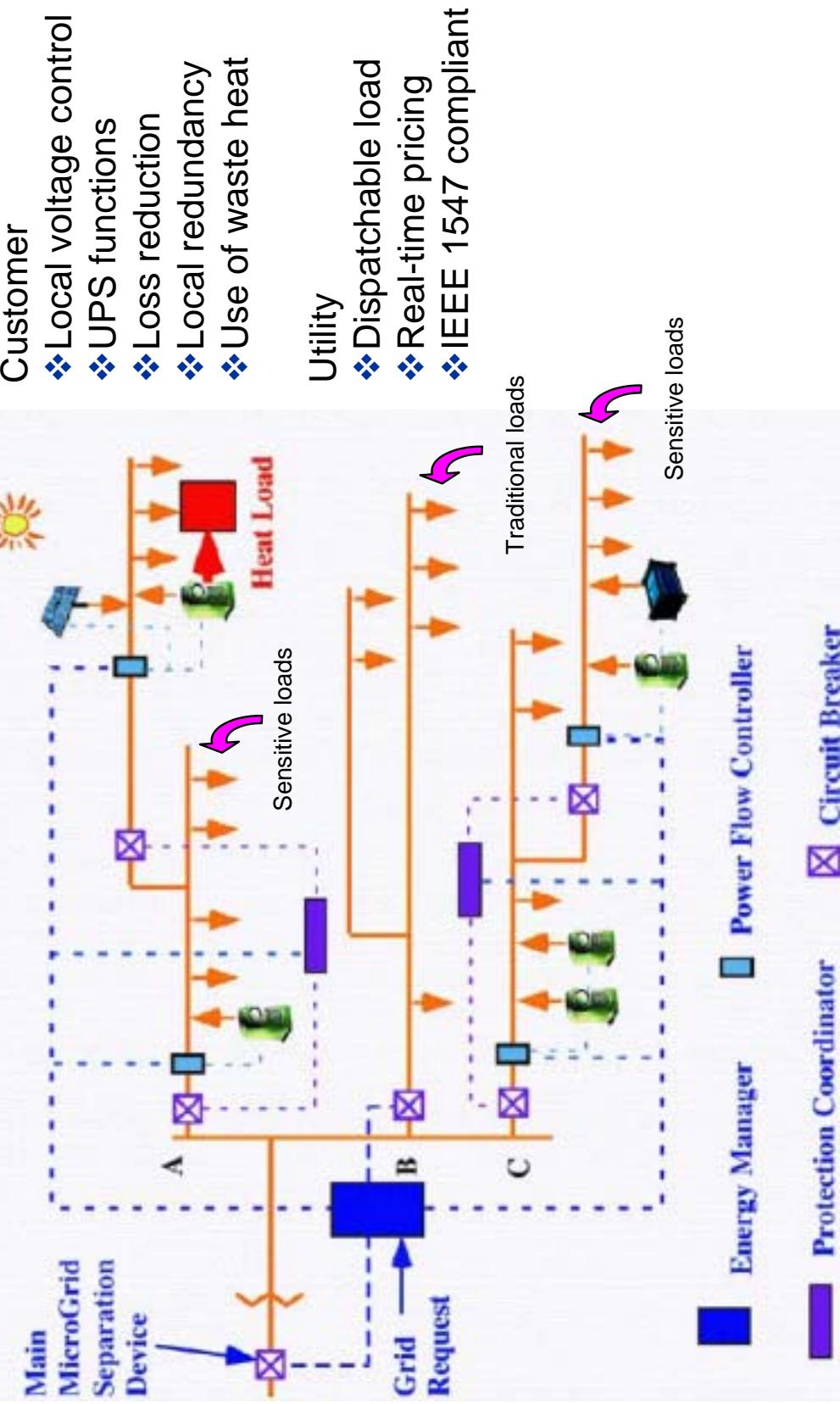


■ The Objectives of this project are to:

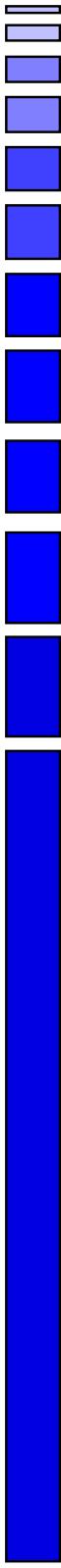
- Finalize controls emulation studies and bench-level testing
- Modify Capstone MTG controls for grid connected and islanded operation
- Design and define equipment specification of test bed and laboratory
- Solicit field demonstration partners and develop field demo plan
- Enhance DER CAM to support lab and field demos



Microgrid



Benefits to CA Ratepayers

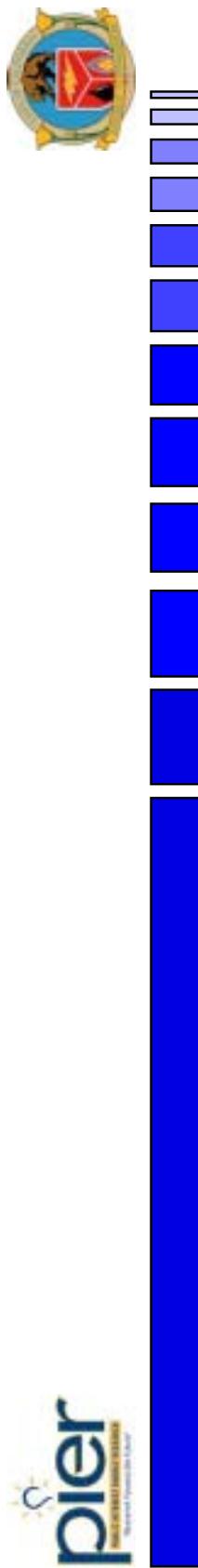


- This project will benefit California electricity ratepayers by meeting the following PIER goals:
 - Improving reliability/quality by creating technologies and control strategies needed to capture full potential of DER
 - Improving energy cost/value by lower the cost of energy delivery

Making the Market Connection



- Project just initiated; successful applications of research results anticipated, but not yet realized.



Demand Response (DR) Enabling Technology Development

Contactor: University of California Office of the
President/California Institute for Energy
Efficiency; Gaymond Yee

Project Amount: \$3,000,000

Ron Hofmann - PIER Contact

Problem Addressed



- Electricity restructuring has fallen short of its promise
- Causes are multiple
- Solutions are being debated but there is remarkable agreement that the demand side should play a more active role to balance supply and demand, modulate wholesale prices and mitigate market power



Project Purpose



- Help build a real-time energy information, signaling, and response infrastructure that is flexible and simple enough so that it can address the next energy crises not only the last one
- Determine the most effective strategies (technology, tariffs, etc.) related to deploying a real-time demand responsive system that are low cost, require minimal end-user interaction yet are effective



The Research



- Begin a process to develop “reference designs” for hardware (e.g., meter, thermostats, etc.) and software (e.g., monitoring and control) systems that enable DR objectives
- Develop an architecture/topology for the transport of DR-enabling (and other related) energy information
- Develop DR enabling technologies for adding advanced (<\$10/node, minimal power consumption, self-locating, self-organizing, etc.) monitoring and control infrastructure

Research (continued)



- Initially, attempt to develop DR-related
 - micro-electromechanical systems (MEMS) sensors and actuators
 - open-system, mesh-architecture communications topologies that can seamlessly share data
 - real-time, distributed-intelligence device networks that are self-organizing
 - enterprise-wide, multi-level control strategies that can absorb legacy systems

Project Objectives



The objectives of this project are:

- (1) to reduce costs by a factor of 10
- (2) to increase capability by a factor of 10
- (3) to develop new ways to meter, monitor and control DR-related equipment
- (4) to explore new ways to manage networks
- (5) to leverage defense and other R&D programs that could help achieve DR objectives



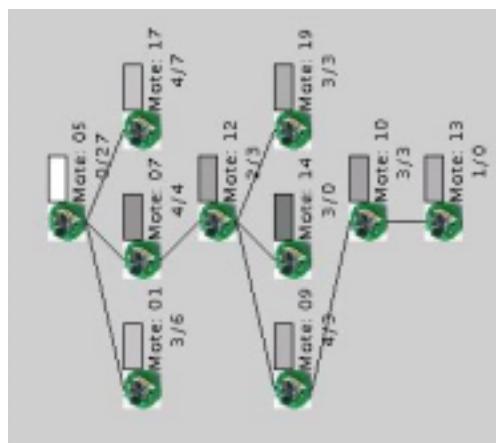
Project Objectives (continued)



■ Examples of initial objectives

- A totally integrated, self-powered communicating meter platform that costs < \$10 in physical parts and enables a total installed cost of <\$25
- A real-time DR-responsive thermostat that costs less than \$30 installed and can automatically implement a user's desires without the user having to learn an arcane programming procedure
- Dynamic communications networks that support legacy equipment and allow new equipment from multiple vendors to join the networks

UCB TECHNOLOGIES*



Pico radio

Ultra-low energy
($<5\text{nJ/bit}$)
Ultra-low power
($<100\text{\mu W}$)

TinyOS

Event-based
operating system for
sensor networks.

Smart Dust

Ultra-small
($<1\text{ mm}^3$)

*this slide
provided by Cliff
Federspiel, UCB

Benefits to CA Ratepayers

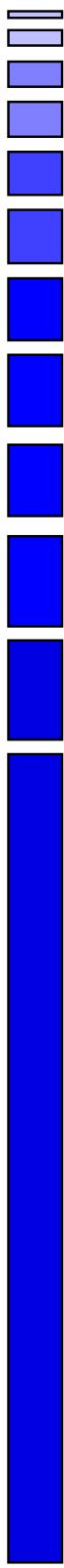


This project will benefit California electricity ratepayers by meeting the following PIER goals:

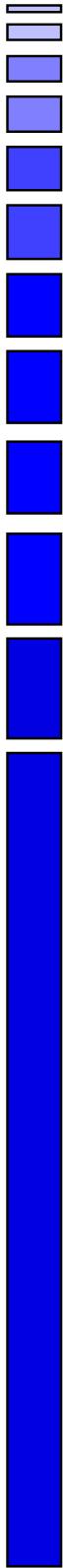
- DR can increase system reliability and moderate electricity cost by providing a demand-side response to supply-side electricity problems.



Pier Making the Market Connection



- None to date
- Project just initiated



Developing a Research Agenda to Address the Utilization of Responsive Load as a Bulk Power System Reliability Resource

Contactor: CERTS - Oak Ridge National
Laboratory; Brendan Kirby

Project Amount: \$125,000

Ron Hofmann - PIER Contact

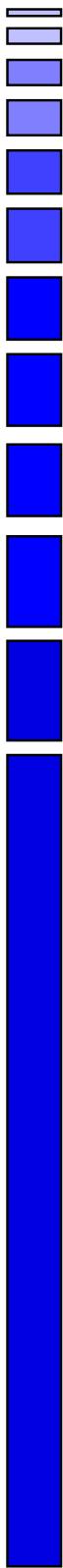
Problem Addressed



- Electricity restructuring has fallen short of its promise
- Causes are multiple
- Solutions are being debated but there is remarkable agreement that the demand side should play a more active role to balance supply and demand, modulate wholesale prices and mitigate market power



Problem Addressed, cont.



- Responsive load appears to be a greatly under-utilized resource for addressing power system adequacy and reliability. Institutional, economic, and technical reasons have been proposed for this failure
- Responsive loads may be an especially important resource in a region with transmission and generation constraints

Project Purpose



- Help build a real-time energy information, signaling, and response infrastructure that is flexible and simple enough so that it can address the next energy crises not only the last one
- Determine the most effective strategies (technology, tariffs, etc.) related to deploying a real-time demand responsive system that are low cost, require minimal end-user interaction yet are effective



Project Purpose, cont.



- Understand why responsive load been a greatly under-utilized resource for addressing power system adequacy and reliability
- Understand how responsive loads could be used by the CAISO in a region with transmission and generation constraints, e.g., San Francisco



The Research



- Develop a research agenda for using responsive load as a system reliability resource
- Work with CAISO personnel to develop a research agenda to identify
 - how responsive loads could increase power system reliability and adequacy
 - what behaviors are desirable
 - what reliability services (ancillary services) these loads could provide
- Write up the research agenda

Project Objectives



- Identify long-term and short-term goals including a vision of how the power system of the future should interact with loads.
- Identify specific research areas to further short-term and long-term goals. These may include developing solutions to institutional, economic, and technical problems. They may include projects aimed at developing confidence in new approaches for individual loads, the CAISO, and/or regulators.



Benefits to CA Ratepayers

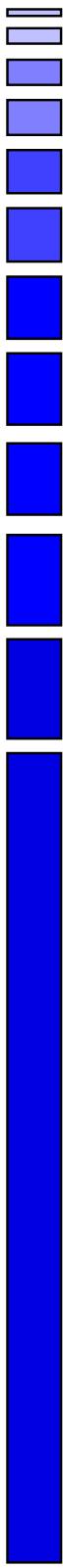


This project will benefit California electricity ratepayers by meeting the following PIER goals:

- DR can increase system reliability and moderate electricity cost by providing a demand-side response to supply-side electricity problems.



Pier Making the Market Connection



- Project just initiated





Large Commercial, Industrial, and Institutional (LCI&I) Demand Response (DR) Demonstrations and Case Studies

Contactor: CERTS - Lawrence Berkeley National Laboratory; Mary Ann Piette

Project Amount: \$446,000

Ron Hofmann - PIER Contact

Problem Addressed



- Electricity restructuring has fallen short of its promise
- Causes are multiple
- Solutions are being debated but there is remarkable agreement that the demand side should play a more active role to balance supply and demand, modulate wholesale prices and mitigate market power



Project Purpose



- Help build a real-time energy information, signaling, and response infrastructure that is flexible and simple enough so that it can address the next energy crises not only the last one
- Determine the most effective strategies (technology, tariffs, etc.) related to deploying a real-time demand responsive system that are low cost, require minimal end-user interaction yet are effective



The Research



- The project addresses these research questions
 - Do LCI&I facilities represent a class of electricity loads that can provide automated and substantial demand response (DR) to deal with future California (CA) energy crises?
 - What is the character of the DR that CA can expect when real-time signals are sent to LCI&I facilities?
 - What are the gaps in DR enabling technologies that need to be addressed to make it possible to implement statewide DR on LCI&I facilities?

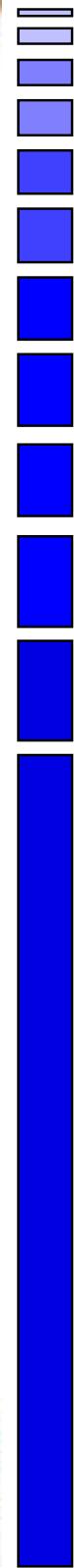
The Research (continued)



- Through case studies, establish a baseline* DR capability for the State's LCI&I facilities by defining the amount of DR that might be available from these facilities during the next electricity crisis

*The baseline will only include already in-place technologies and control strategies

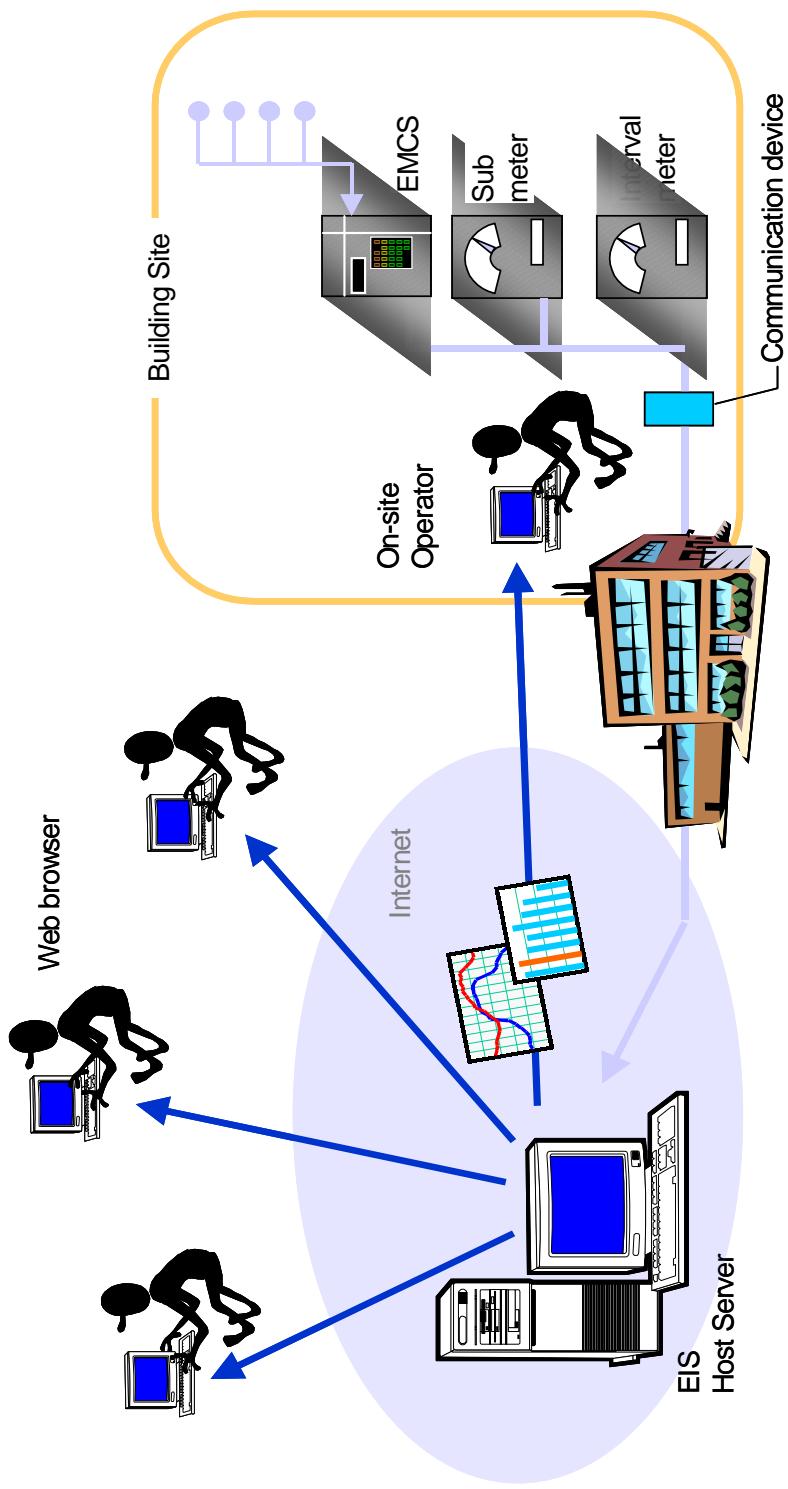
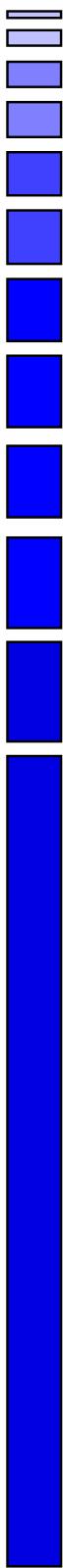
Project Objectives



The Objectives of this project are to:

- Improve understanding of the status of automated DR building systems, particularly the levels of automation in best practices
- Quantify demand-savings response of automated systems
- Identify technology gaps and priorities to improve future systems
- Understand key features of the market for DR systems and decision making perspectives about the adoption of DR technology
- Develop and test a real-time signal to initiate an automated demand response

LCI&I Infrastructure





Benefits to CA Ratepayers



This project will benefit California electricity ratepayers by meeting the following PIER goals:

- DR can increase system reliability and moderate electricity cost by providing a demand-side response to supply-side electricity problems.



Making the Market Connection



- Project just initiated
- Initial conversations between the contractor, vendors and prospective demonstration building site owners indicate that there may a variety of LCI&I facilities in CA equipped to automatically respond to real-time DR signals





Case Study of Real-time Pricing (RTP) Demand Response (DR) Program Experience in New York

Contactor: CERTS - Lawrence Berkeley National
Laboratory; Charles Goldman

Contract Amount: \$265,000

Ron Hofmann - PIER Contact

Problem Addressed



- Price responsive load is crucial to facilitate competitive electricity markets and address problems that have occurred under electricity restructuring
- Need to develop effective policies, programs and enabling technologies to facilitate Price Responsive Load



Project Purpose



- Help build a real-time energy information, signaling, and load response infrastructure that is flexible and simple enough so that it can address the next energy crises
- Determine the most effective strategies (technology, tariffs, etc.) related to deploying a real-time demand responsive system that are low cost, require minimal end-user interaction yet are effective



The Research



- Assess customer response to dynamic pricing tariffs and other strategies to increase demand response
- Study dynamic pricing and DR programs in New York (NY) State that have attracted significant participation and support from large customers for four years in a restructured and well-functioning electricity market
- Evaluate the NY experience with respect to how it might be used in California to create Price-Responsive Load

The Research (continued)



- Case Study conducted in two phases
- Phase 1: Initial scoping analysis
 - analysis of customer bills to estimate demand elasticity
 - interviews with policymakers and key stakeholders on regulatory process and key policy issues to resolve
- Phase 2: Comprehensive analysis
 - analysis of how and why customers respond through customer market survey
 - combine billing and customer survey data to develop customer behavior and performance models
 - comparison with control group on fixed price tariffs
 - assess implications & lessons learned for CA's electricity market.

Project Objectives

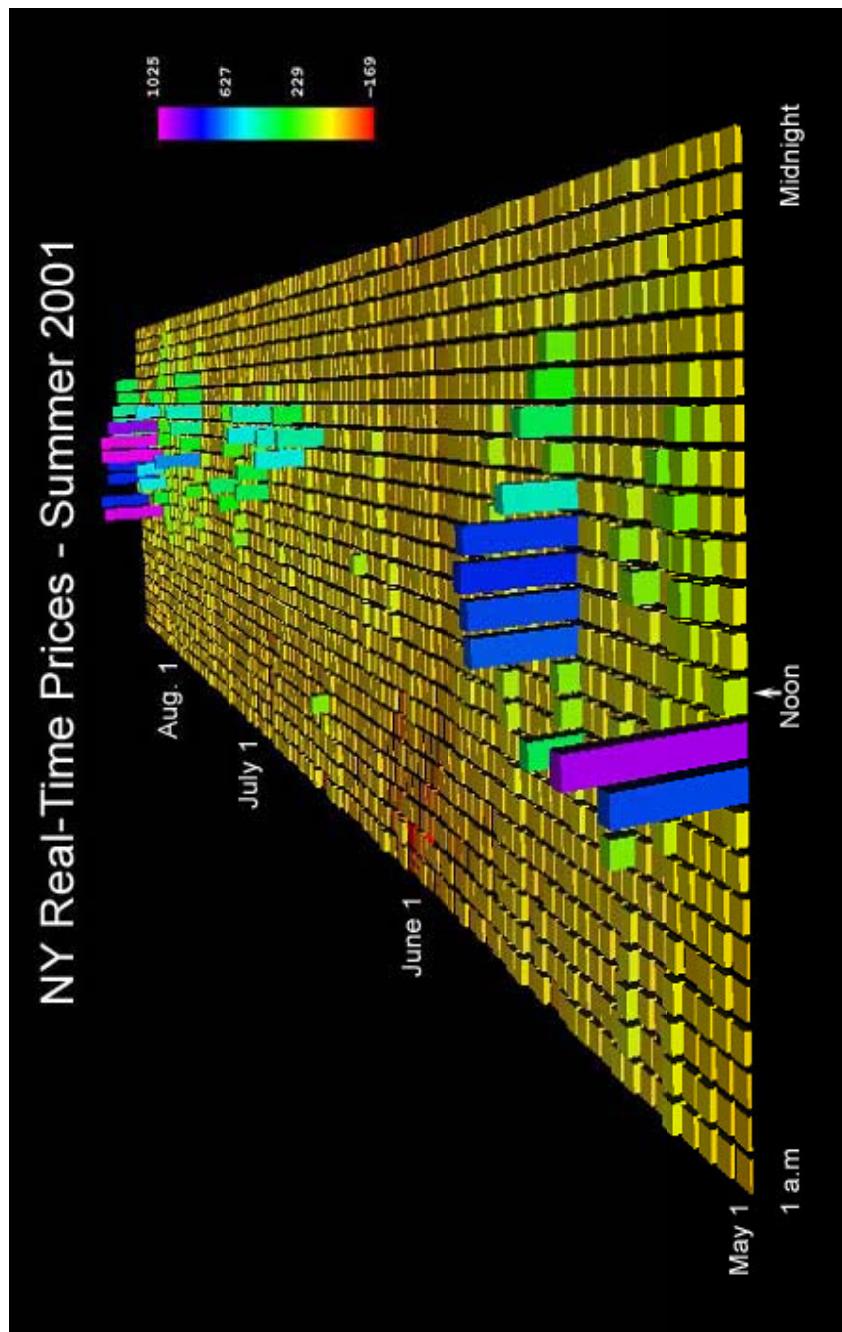


The Objectives of this project are to:

- Assess customer response to tariffs based on day-ahead wholesale market prices (i.e., RTP) in a retail competition environment
- Assess relative merits and relationship between alternative programs/strategies (e.g., “real-time pricing” tariffs, price-responsive load bidding programs administered by ISOs) that seek to increase customer participation in electricity markets



Wholesale Market Price Topology



Benefits to CA Ratepayers



This project will benefit California electricity ratepayers by meeting the following PIER goals:

- Increasing electric system reliability using price-responsive load methods
- Mitigating electricity price volatility
- Facilitating development of competitive electricity markets



Pier Making the Market Connection



- Project just initiated
- Forming Stakeholder Advisory Group to provide input on project workplan, key questions/issues on RTP for CA customers and policymakers
- This work could provide useful information for the DR Order Instituting Rulemaking (OIR) process currently underway



Engineering Data Management, Inc.

Development of a Real-Time
Monitoring/Dynamic Rating System for
Overhead Lines

Contract # 500-98-034

Contract Amount: \$499,402

David A. Chambers - PIER Contract Manager

Problem Addressed



- “Power Outages Cost \$119 Billion Per Year” - *Air Conditioning Heating Refrigeration The News*
(August 27, 2001)





Project Purpose



- Increase the efficient use of overhead transmission lines.
- Better utilization of alternative load paths during emergency operations.
- Monitor status of clearances/sags in “safety critical” areas.



The Research



- The research, development and demonstration of a robust, commercially viable system for real-time conductor ground clearance/sag monitoring and dynamic rating of transmission lines

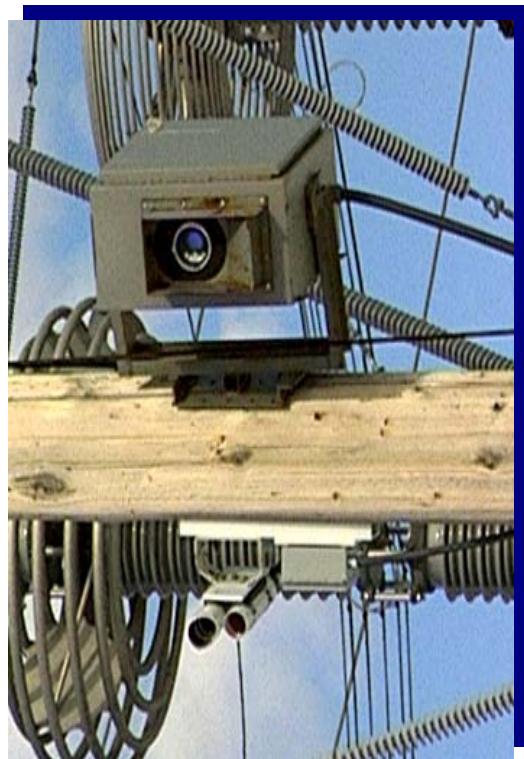
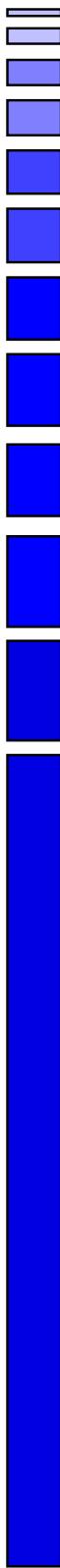
Project Objectives



- The objective of this project is to increase the efficient use of overhead transmission lines by developing a monitoring system which provides instantaneous information on the status of the lines' power-carrying capacity and safety code compliance related to power-line ground clearance.

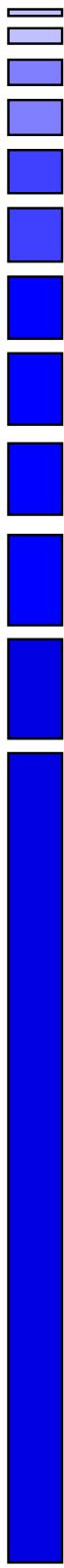


Machine Vision - Point Source to Tower Measurement





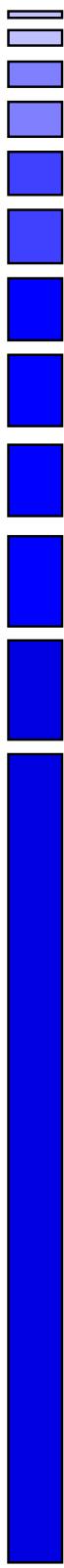
PIER Benefits to California Ratepayers



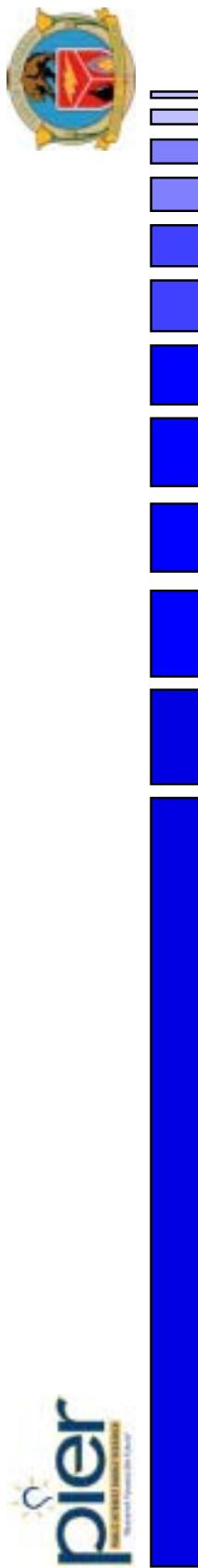
- This project will benefit California electricity ratepayers by meeting the following PIER goals:

- Improving the energy Cost/Value by deferral of capital expenditures of \$150-200 million for the construction of new transmission lines in the next 10 years.
- Improving the system's Reliability and Quality enabled by improved knowledge of line capacity under normal and emergency conditions.

Making the Market Connection



- “Innovative device monitors sag and clearance enabling two utilities to increase power flow and defer line rebuilds.” - Transmission & Distribution World September 2002
- The use of this technology has been applied to the Public Service Company of New Mexico(PNM) and Tennessee Valley Authority(TVA)
- “PNM believes collected data may justify adding 15 to 25 years to the currently projected end-of-life for the conductors being monitored.” - Transmission & Distribution World September 2002



Material Integrity Solutions, Inc.

Sagging Line Mitigator Project

Contract # 500-98-042

Contract Amount: \$900,000

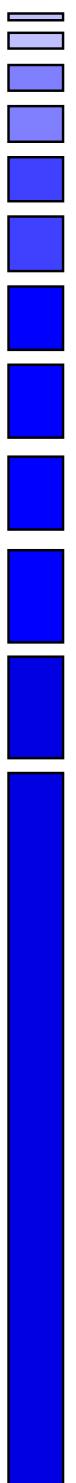
David A. Chambers: PIER Contract Manager

Problem Addressed



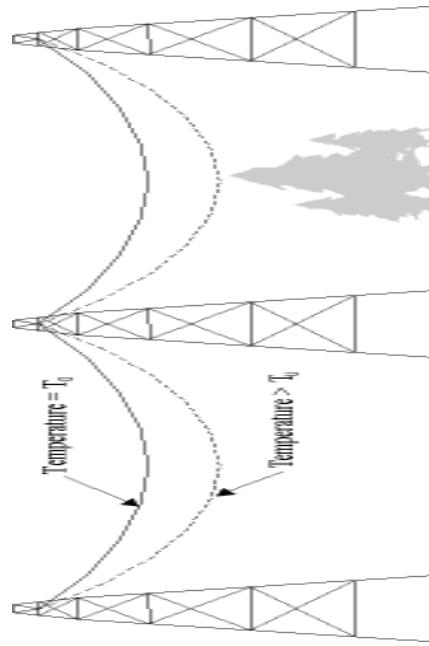
- “Power Outages Cost \$119 Billion Per Year”(nationwide)-*Air Conditioning Heating Refrigeration The News (August 27, 2001)*

Pier Problem Addressed, Continued



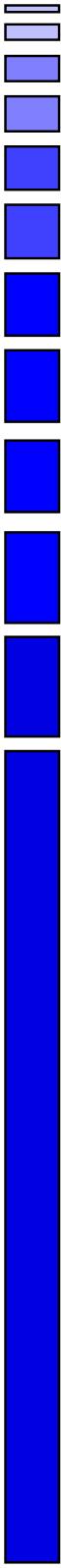
- One of the major causes of this problem is sagging power transmission lines and restricted power capacity transmission

- As power transmission lines heat-up (due to ambient temperature and increasing electric current) they begin to sag, and could cause fires.



By law the transmission lines have a minimum line to ground clearance, thus artificially reducing power transmission capacity.

Project Purpose



- Automatically and mechanically pull in the slack of sagging power lines.
- Compensate for line sag caused when ambient temperature increases.



The Research



- The research, development and demonstration of a Sagging Line Mitigator (SLiM) device to compensate for line sag caused when ambient temperature increases.
- The SLiM device to be able to vary its range of motion to accommodate different line sag requirements.
- Serviceable Lifetime: Device should match industry standard for transmission line hardware.
A target life span of 30-50 years.

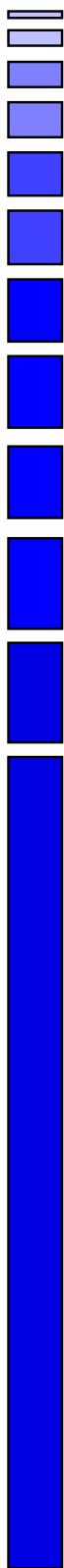
Project Objectives



The Objectives of this project are to:

- Develop an automatic device.
- Develop a self-adjusting mitigating device such that the same change in ambient temperature that causes the line to sag will concomitantly cause the device to act to mitigate the line sag.
- Develop an essentially maintenance free device.

SLiM Device Rendering



Benefits to California Ratepayers

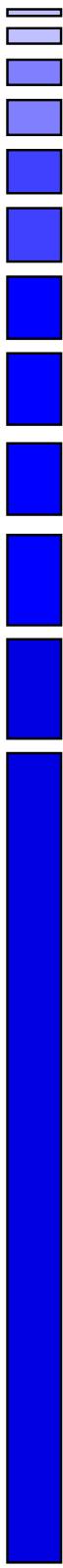


- This project will benefit California electricity ratepayers by meeting the following PIER goals:
 - Improving Reliability and Quality enabled by reducing the curtailment of electric deliveries due to line capacity constraints (brown/black-outs).
 - Improving Safety enabled by reducing the risk of electrocution and vegetation fires caused by sagging lines.





Making the Market Connection



- Successful full-scale field functionality tests were performed at Pacific Gas & Electric's Livermore facility in July 2002.
- The Electric Power Research Institute determined this project has value to its members and initiated field tests on the device.
- Pacific Gas & Electric, San Diego Gas & Electric and Los Angeles Department of Water and Power Engineering Supervisors stated they want SLiM in their transmission toolbox.



W. Brandt Goldsworthy & Associates

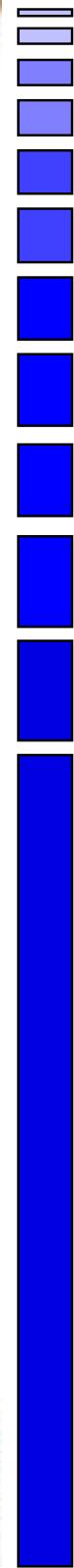
Development of a Composite Reinforced Aluminum Conductor (CRAC)

Contract # 500-00-003

Contract Amount: \$1,100,479

Jamie Patterson - PIER Contract Manager

Problem Addressed



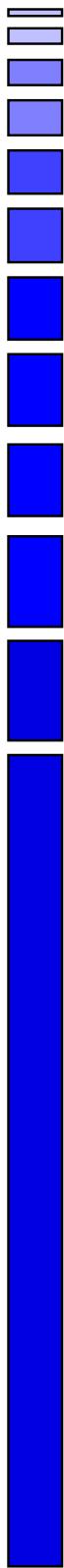
Transmission Lines have capacity limits.

■ These consists of primarily two forms:

- Stability Constraints
- Thermal Constraints

■ Thermal limitations are the most common constraints that limit the capability of a transmission line, cable, or transformer to carry power.

Problem Addressed, cont.



- Too much current will overheat a transmission line.
- Overheating causes the transmission line to lose strength.
- Weak transmission lines don't last as long as strong ones.
- Once weakened, additional overheating of the line will permanently stretch the line and may cause its clearance from the ground to be less than required for safety.

Project Purpose



- This is a follow on contract to #500-98-035 to develop a composite reinforced aluminum conductor that will run cooler and will operate without violating present electrical clearances to ground and other objects. This contract is to develop the conductor manufacturing capability.

The Research



- This research is performing an engineering process called “Design for Manufacturability”.
This is an iterative process in which the material handling equipment is designed along with the material itself. In this project the challenge has been to find a composite material that can be easily pultruded through a small die.



Project Objectives

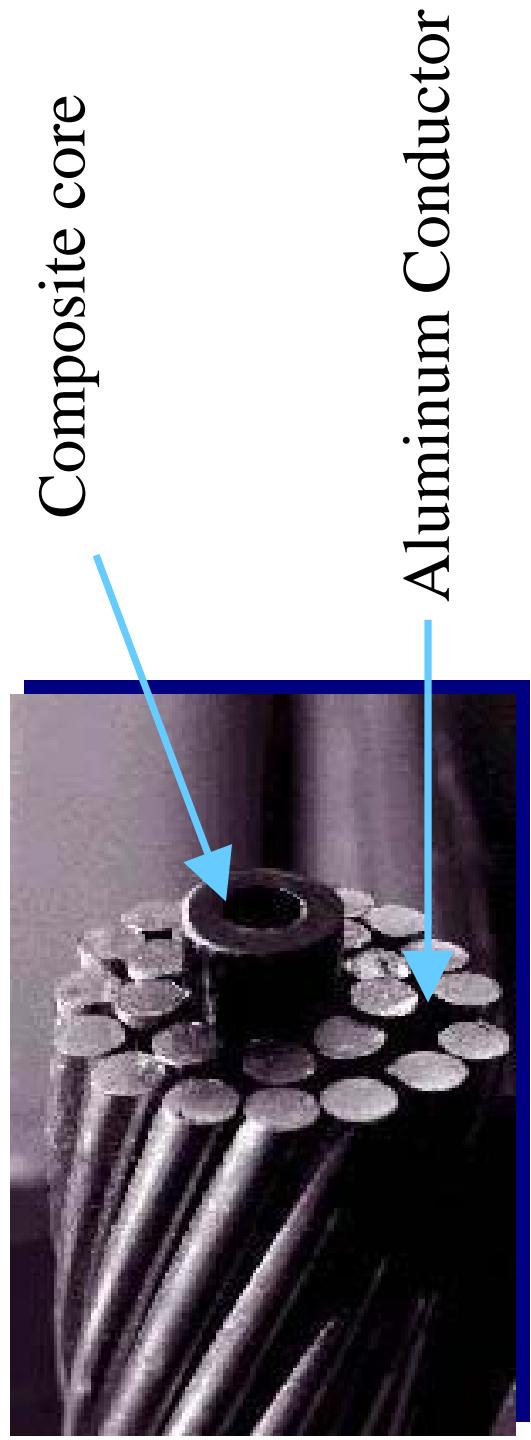


The Objectives of this project are to:

- Develop manufacturing equipment and methods to promote a Composite Reinforced Aluminum Conductor that meets the following performance criteria:

- Less sag for a given temperature.
- Higher temperature rating for a given amount of sag.
- Higher current capacity for a given amount of sag.

Close-up of Conductor

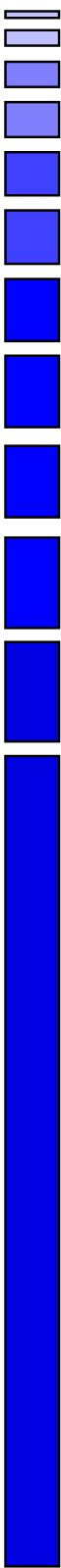


Composite core

Aluminum Conductor



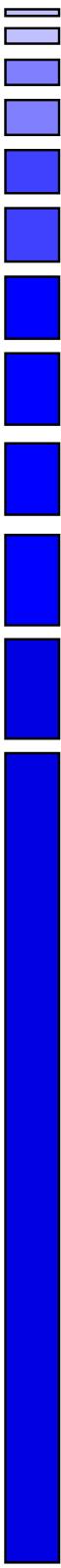
PIER Benefits to California Ratepayers



- This project will benefit California electricity ratepayers by meeting the following PIER goals:
 - Improving the energy Cost/Value by deferral of capital expenditures of \$150-200 million for the construction of new transmission lines in the next 10 years.
 - Improving the system's Reliability and Quality enabled by improved line capacity under normal and emergency conditions.



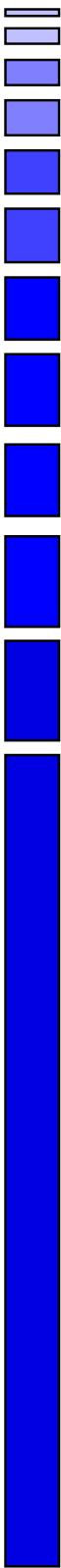
Making the Market Connection



- Testing of the new conductor by Southern California Edison should start in Spring, 2003.



PIER Real-Time Ratings for Path 15



Contractor: The Valley Group

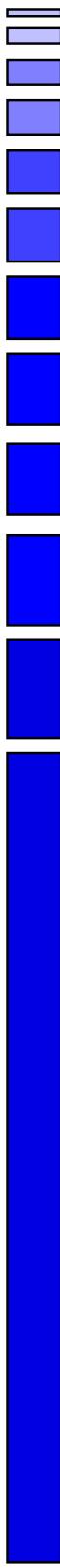
Contract #700-00-006

Contract Amount: \$369,204

Don Kondoleon - PIER Contract Manager



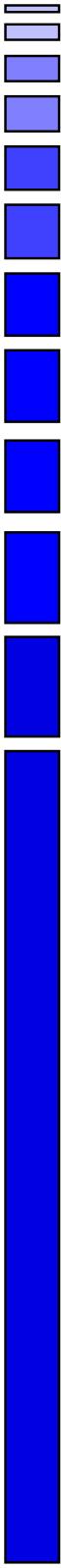
Problem Addressed



- Transmission bottlenecks often deter adequate supply and subsequently increase prices
- Congestion cost for Path 15 in the fourth quarter of 2000 alone was \$169 million



Project Purpose



- Demonstrate the feasibility of implementing real-time transmission line ratings for Path 15, which is one of the most complex gates in the California transmission system



The Research



- Investigates the feasibility of providing real-time transmission line ratings by monitoring the conductor tension and environmental factors for a multiple transmission line path

- Investigates the feasibility of providing a calculated real-time rating for the path directly to the system operators



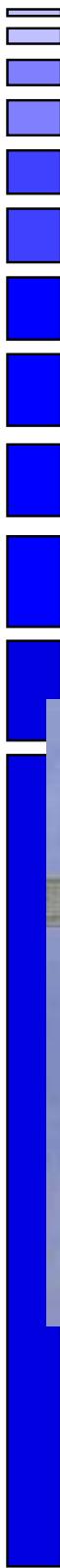
Project Objectives



- Increase the power transfer capability through Path 15 by 15-20% on an annual basis
- Decrease utility expenditures by \$1 million per month through decreased transmission congestion on Path 15 during peak periods
- Identify other possible paths in California which could benefit from real-time transmission line ratings

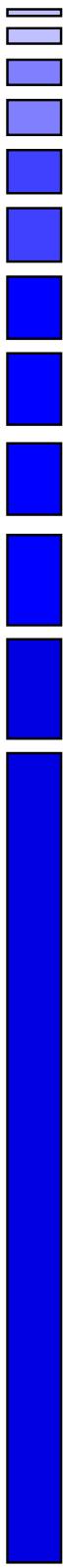


Deployment of Monitoring System





PIER Benefits to California Ratepayers



This project will benefit California's electricity ratepayers by meeting the following PIER goals:

- Improving the reliability and quality of California's electricity by increasing power transfer capability on an annual basis through Path 15
- Improving energy cost/value of California's electricity by reducing electricity expenditures through decreased transmission on Path 15 during peak periods



Pier Making the Market Connection



- Real-time ratings software for Path 15 results have been verified by the grid operators
- Draft report identifies other CA. paths that could benefit from real-time transmission line ratings
- PG&E has purchased and installed additional real time ratings monitors in critically constrained parts of the San Francisco Bay Area
- WAPA and SMUD are working with the CEC to develop a follow-on project to help alleviate voltage constraints in the Sacramento area through the use of real-time ratings



Electric System Reliability Project - Real Time System Monitoring and Control

Contractor: Lawrence Berkeley National Laboratory

Participants: CERTS, PSERC, EPRI, CAISO

Contract #150-99-003

Contract Amount: \$1,105,000

Don Kondoleon - PIER Contract Manager

Problem Addressed



- The transition of California's electricity supply and delivery infrastructures from vertically integrated, regulated and government-controlled organizations to deregulated, competitive market-driven institutions dictates that power supply, network management and control systems must be driven to find innovative solutions to the traditional methods in order to ensure stable power flows, frequency and voltage control
- Innovative voltage management tools could have prevented the August 10, 1996 blackout of west coast

Project Purpose



- Lay the groundwork for a transition in reliability management philosophy from one based on passive readiness to one based on active anticipation and pre-emptive actions in response to impending emergencies
- Provide integrated research and technology development that will help produce quicker and more flexible options for meeting the reliability, stability and ancillary service needs of California's electricity consumers



The Research



- Identify and define priorities for publicly-funded research needed to support a restructured California electricity industry
- Identify, develop and deploy real time system management tools that will allow California's interconnected power system to operate closer to its actual physical and stability limits



Project Objectives

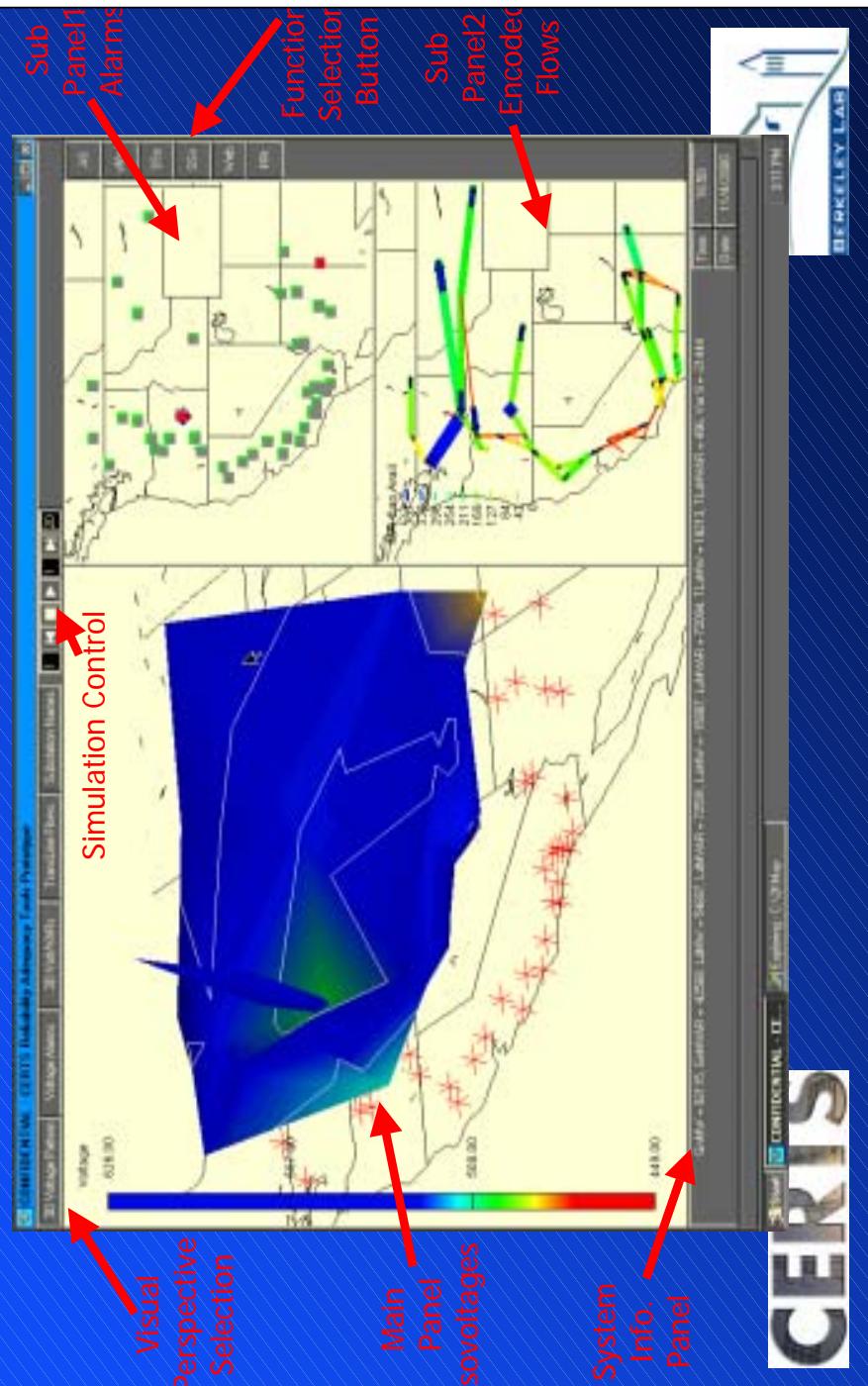


- Reduce the probability of outages (e.g., '96 outage cost exceeded \$2.8 billion.)
- Create tools that are trusted and utilized by CAISO operators to manage the system.
- Reduce CAISO ancillary services costs to 10-15% of the wholesale energy cost which could represent a savings of \$60 million per year

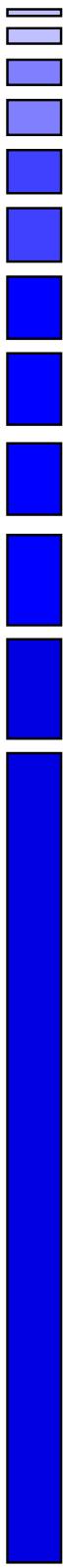




CERTS VAR Management Tool Turns Data Into Information



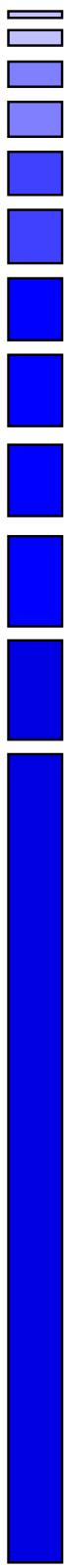
Benefits to California Ratepayers



This project will benefit California's electricity ratepayers by meeting the following PIER goals by:

- Improving the reliability and quality of California's electricity infrastructure by identifying new solutions for a continued stable power supply for a deregulated electricity market
- Improving the energy cost/value of California's electricity by increasing the efficiency of California's competitive electricity market

Making the Market Connection



- Synchronized phasor measurements are now under consideration by the WECC for improved real-time monitoring of system-wide conditions
- Real-time transformer assessment tool is being integrated with the Path 15 real time transmission ratings tool to allow for the most accurate ratings determination under contingency conditions
- CERTS voltage management tool delivered to CAISO. Tool presents real-time information on system conditions in readily understood graphic visuals that facilitate actions.



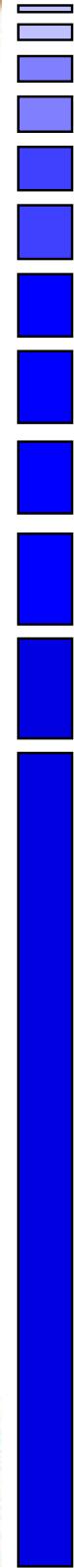
EPRI

High Temperature Low Sag Conductor Tailored Collaborative Project

Project Amount: \$100,000

Janie Patterson - PIER Contract Manager

Problem Addressed



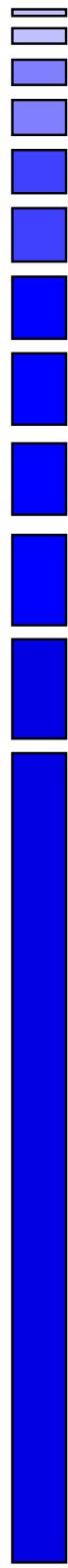
Transmission Lines have capacity limits.

■ These consists of primarily two forms:

- Stability Constraints
- Thermal Constraints

■ Thermal limitations are the most common constraints that limit the capability of a transmission line, cable, or transformer to carry power.

Pier Problem Addressed, cont.



- New high temperature low sag conductors are being developed.
 - Gap (Sumitomo)
 - Invar (Sumitomo)
 - ACSS
 - CRAC (Goldsworthy)
 - ACCR (3M)
- Little is known about how these conductors compare.



Project Purpose



- This project will evaluate and compare the performance of selected high temperature low sag conductors that are capable of significantly increasing the ampacity of thermally constrained transmission lines.

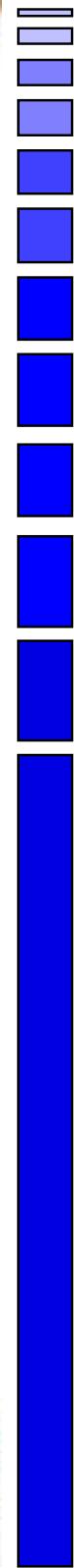
The Research



This research will attempt to answer some of the following questions:

- What are the bundling or spacing considerations?
- What happens to Voltage stability as loading is increased?
- What reactive compensation is required?
- What is corona performance?
- How do you design for different loading (NESC light, medium, heavy) conditions?

Project Objectives

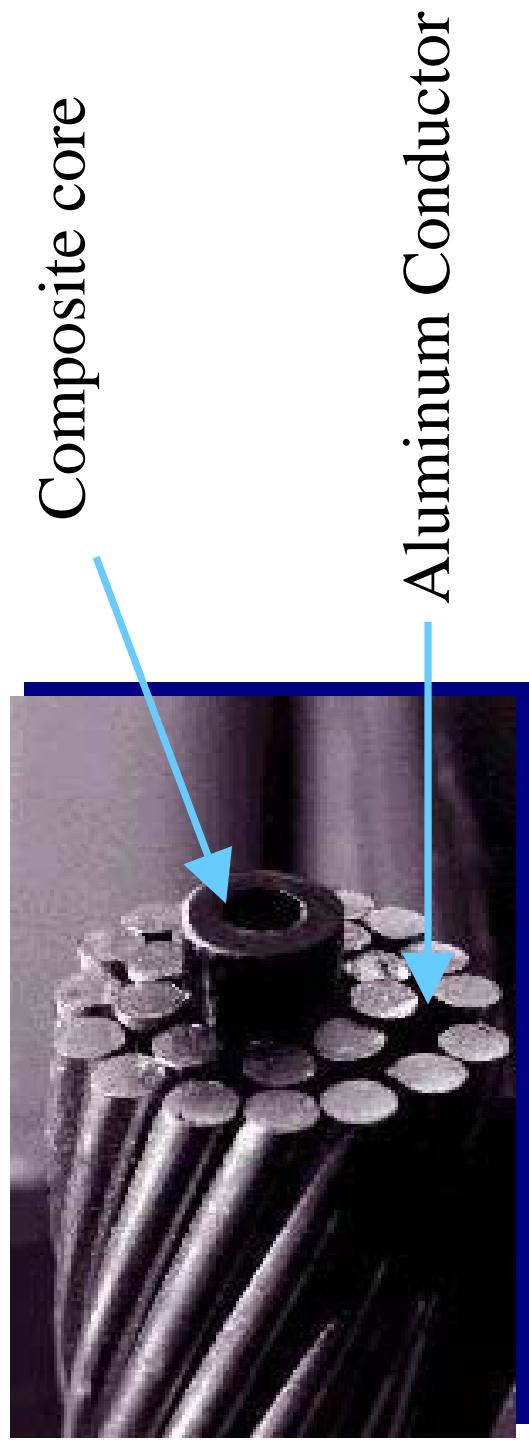


The Objectives of this project are to:

- Determine and compare the engineering characteristics of high temperature low sag transmission line conductors. Specifically:
 - Vibration
 - Sag
 - Tension
 - Current
 - Audible noise/ Radio noise
 - Corona
 - Splice Resistance
 - Voltage



Close-up of one type of high temp low sag Conductor





PIER Benefits to California Ratepayers



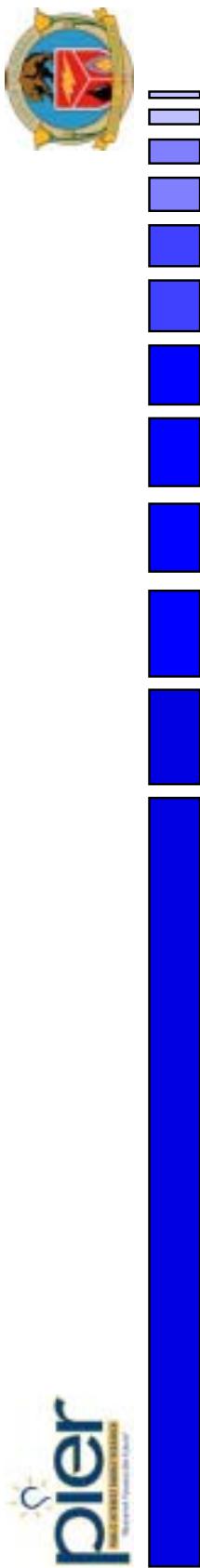
- This project will benefit California electricity ratepayers by meeting the following PIER goals:
 - Improving the energy Cost/Value by deferral of capital expenditures of \$150-200 million for the construction of new transmission lines in the next 10 years.
 - Improving the system's Reliability and Quality enabled by improved line capacity under normal and emergency conditions.



Pier Making the Market Connection



- Several utilities are co-funding this field test to evaluate utilizing new cables in their systems.
- This project is expected to start conductor field trials in March 03.
- Low-sag conductors may offer cost effective and environmentally-friendly ways to increase transmission capacities in California
- First performance reports are expected in July 03.



AFS Trinity Power Corporation

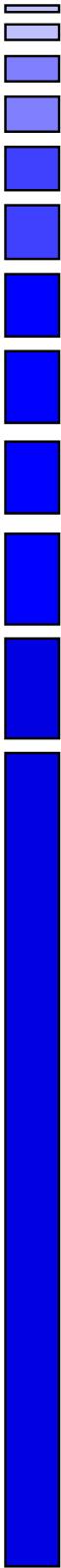
Flywheel Power System Development

Contract # 500-01-036

Contract Amount: \$1,057,406.00

Janie Patterson - PIER Contract Manager

Problem Addressed



- Current Flywheel Power Systems are not large enough to be useful.
- Current Flywheel Power Systems do not integrate a flywheel motor/generator together with the power electronics to create a complete stand-alone system that users can purchase.
- Current Flywheels do not use advanced technologies to achieve high performance and are unsuitable for a wide range of applications.

Project Purpose



- Design and demonstrate a 2kWh Flywheel Power System.
- Integrate a flywheel motor/generator together with the power electronics to create a complete stand-alone system.
- Use advanced technologies to achieve high performance and a wide range of applications.



The Research

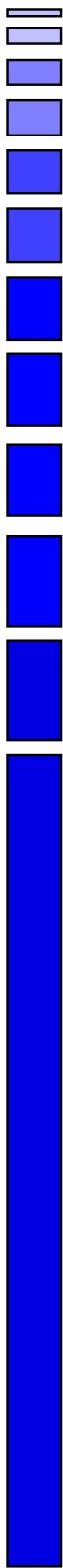


- Develop a composite core rotor.
- Develop the power electronics to perform power conversion and control.
- Integrate into a complete stand alone package.

FOR MORE INFO...

- <http://www.afstrinity.com/>
- http://www.afstrinity.com/tech/tec_fps.html

Project Objectives



The Objectives of this project are to:

- Achieve an output power of 200 kW
- Store 2.0 kWh/7.2 MJ of usable energy
- Have a minimum discharge time of 25 seconds
- Obtain a cycle life of at least 100,000 charge / discharge cycles



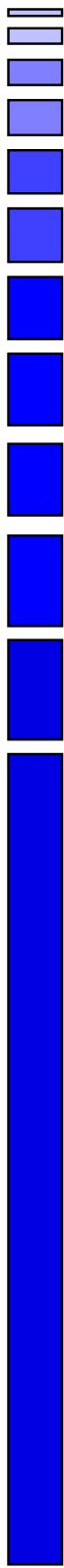


Cut away of Flywheel





PIER Benefits to California Ratepayers



This project will benefit California electricity ratepayers by meeting the following PIER goals:

- Improves the reliability and quality of California's energy system.
- Able to inject or absorb power as needed.

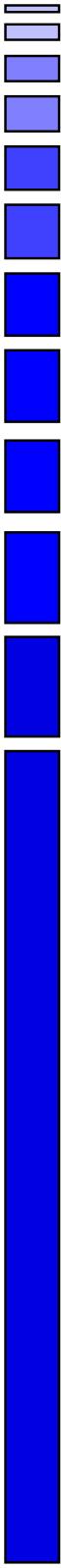


Making the Market Connection



- Interest expressed by San Francisco MUNI for possible energy recovery in train braking and reducing transformer sizes in relay stations.





EPRI Tailored Collaboration - Seismic Qualification of Substation Equipment Using IEEE 693- 1997 (Recommended Practice for Seismic Design of Substations)

Project Amount: \$20,000.00

David A. Chambers, PIER Project Manager



Problem Addressed



- Non-seismically qualified substation equipment is a primary cause of damage and disruptions from earthquakes in California.



Project Purpose



- Identify substation equipment of concern to stakeholders.
- Develop a seismic qualification test for substation equipment identified.
- Seismically qualify substation equipment in accordance to IEEE 693 -1997 “Recommended Practice for Seismic Design of Substations”.



The Research



- This testing of substation equipment brings together a consortium of utilities and public research entities to develop a consensus of seismic qualification testing methods for using IEEE 693 - 1997.

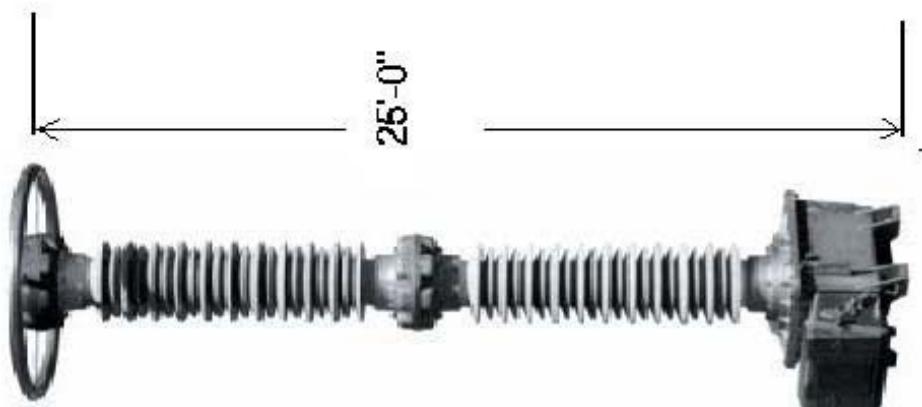
Project Objectives



The objectives of this project are to:

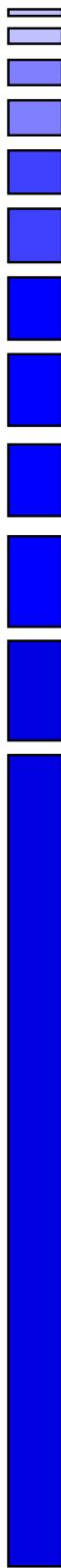
- Reduce qualification cost through joint effort of the participating utilities
- Qualify substation equipment of special concern to participating utilities.

Coupling Capacitor Voltage Transformer (CCVT)



Coupling capacitor voltage transformers (CCVT) are used in high voltage and extra high voltage transmission systems to provide potential outputs to metering instruments and to protective relays. Vulnerable to earthquake damage due to length and mass.

Benefits to CA Ratepayers

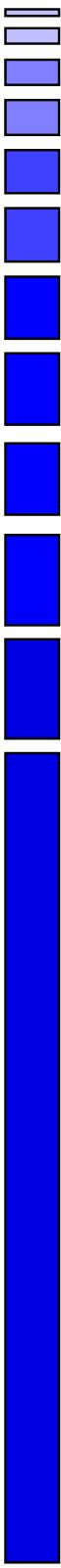


- This project will benefit California electricity ratepayers by meeting the following PIER goals:
 - Improving of the reliability/quality of California's Electricity by reducing earthquake damaged equipment.
 - Improving the safety of California's electricity by identifying and mitigating seismically weak points in our substations.

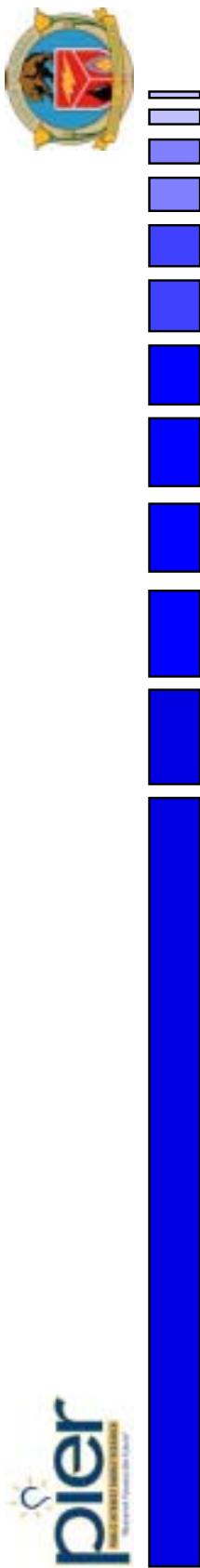




Pier Making the Market Connection



- This project will be submitting recommended changes to the IEEE Standard 693 to improve the reliability/ quality and safety of California's electricity.



CENTER FOR THE STUDY OF ENERGY MARKETS

A Research Center at the
University of California Energy Institute

Contract Amount: \$2,050,000

Dr. Michael Jaske - PIER Grant Manager

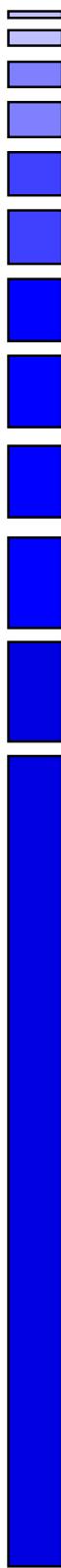
Problem Addressed



- Despite an initial commitment to energy markets, the problems encountered in 2000 reveal that California needs to better understand how electricity and natural gas markets work and how market designs can be improved.



Project Purpose



- Foster economic market performance research at UCETI by creating a residential center for market researchers.
- Communicate research findings through academic seminars, research papers, technical and policy conferences, and training sessions.
- Improve knowledge among staff of regulatory agencies and key institutions.



The Research



■ CSEM fosters research in five topic areas:

- reliability in a market-based structure
- interaction between demand response and market competitiveness
- assessing the relationship between market design and efficiency
- tools for mitigating market power; and
- the interface between the electricity system and environmental regulation.



Project Objectives

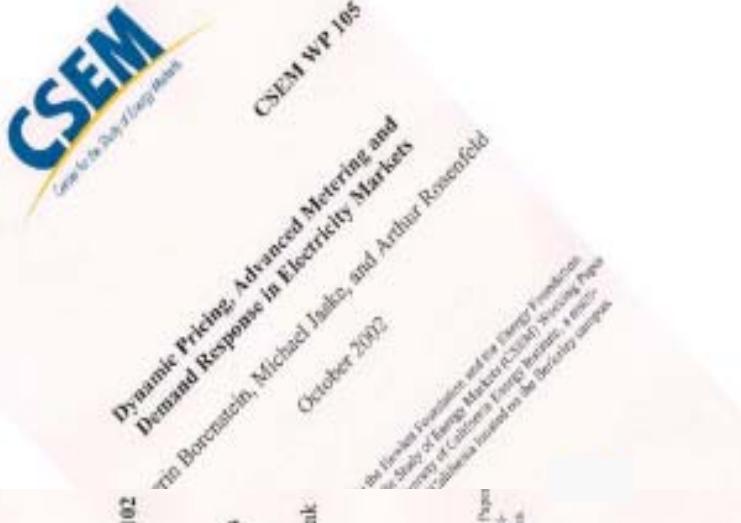
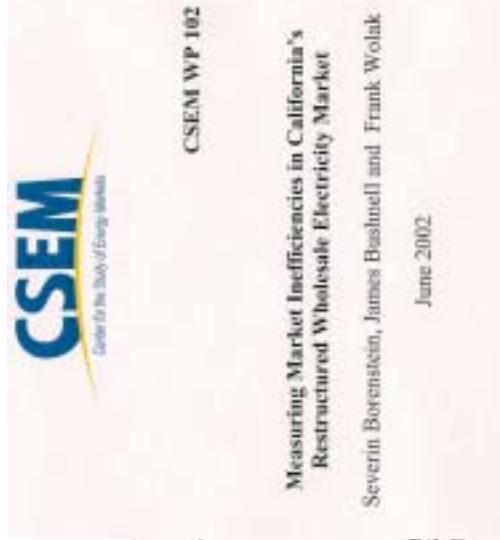
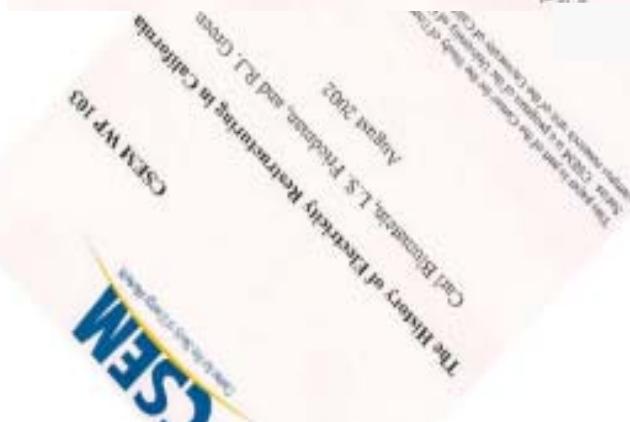


The Objectives of this project are to:

- Attract nationally and internationally known energy researchers to UCERI for periods of residential research.
- Publish five research and three policy papers each year.
- Organize and implement one technical and one policy conference each year.
- Foster interaction among energy agencies and researchers through training sessions/seminars.
- Be relevant to policy debates.

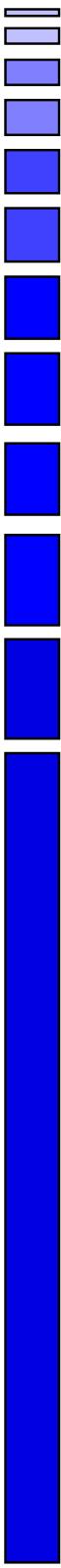


CSEM Working Paper Series





PIER Benefits to California Ratepayers

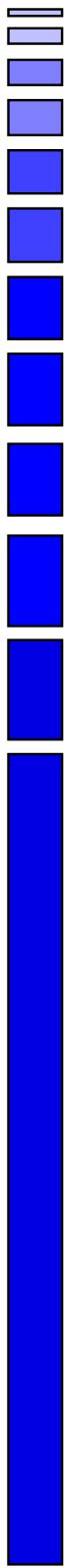


This project will benefit California electricity ratepayers by meeting the following PIER goals:

- Improving understanding of the relationship between the economic efficiency and performance of various market designs.
- Studying specific performance as a foundation for fine tuning market design.



Pier Making the Market Connection



- First Annual Policy Conference held at the Energy Commission on 11/14/02.
- CSEM has attracted researchers who include well known academic researchers in California and also two members of CAISO Market Surveillance Committee.
- Conducted more than a dozen seminars at UC-Berkeley and UC-Davis locations.
- Announced training course for 1/13-14/2003.
- Created new CSEM research paper series/website.



Alternative Energy Systems Consulting

Intelligent Software Agents for Control and
Scheduling of Distributed Energy Resources

Contract # 500-01-016

Contract Amount: \$499,970

Jamie Patterson - PIER Contract Manager

Problem Addressed



- The electric system is quickly evolving into a large interconnected network of distributed resources with diverse ownership.
- New technology is needed to facilitate electronic commerce (i.e., buying and selling energy, monitoring supply and demand, system monitoring and maintenance, etc.) within the electricity system”



Project Purpose



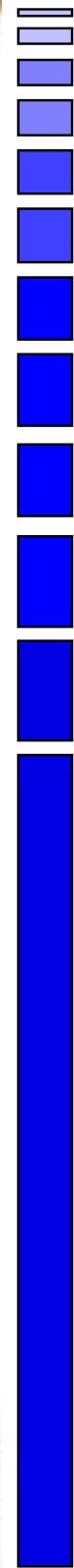
- This is a follow on contract to #500-98-040 to develop an automated solution to bidding and dispatching distributed energy resources in a cost effective manner.
- Intelligent agents using sophisticated algorithms can facilitate the coordinated scheduling of multiple distributed energy resource assets. This decentralized decision making will reduce the expertise needed to own and operate distributed energy resources, allowing greater participation by owners of distributed energy resources in California's competitive energy industry.

The Research



- The key to developing an automatic solution is to develop Intelligent Software Agents that monitor price, weather, future local energy needs, and costs to make distributed decisions.
- Intelligent agents have the ability to monitor their own execution environment, communicate with other agents or the user and maintain some representation of their own state. An intelligent agent is able to complete its task on its own.
- The challenge is to be able to do this in real time, inexpensively.

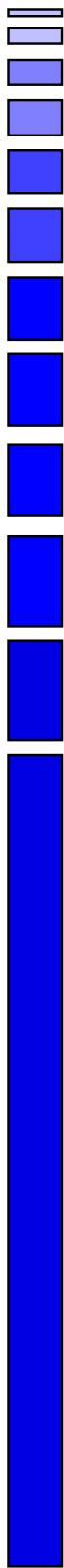
Project Objectives



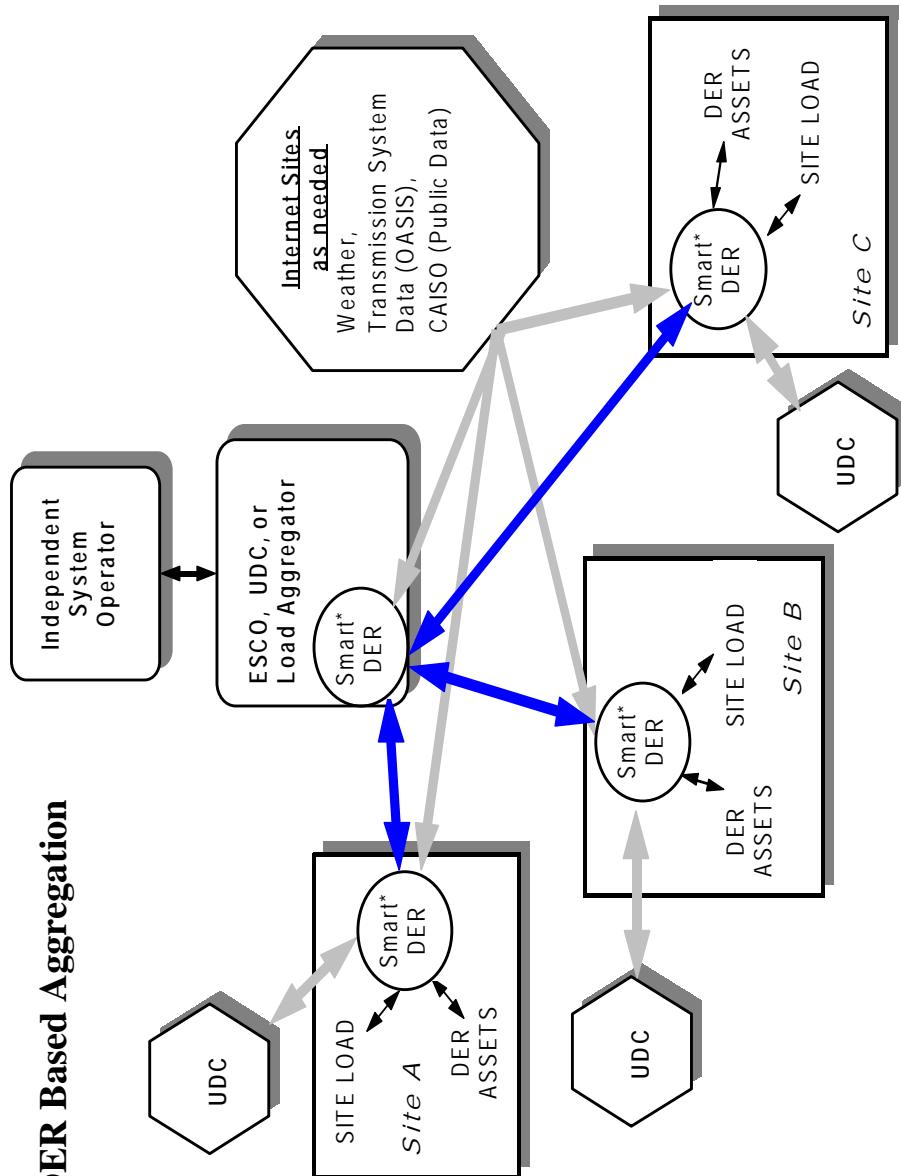
The Objectives of this project are to:

- Revise the functionality to reflect changes in the California Energy Marketplace.
- Get a partner to integrate the product into their devices for a field test.
- Refine the interface requirements to enable operation.
- Complete a feasibility test scheduling and controlling actual DER units.

Pier Sample Agent-based Market Solution



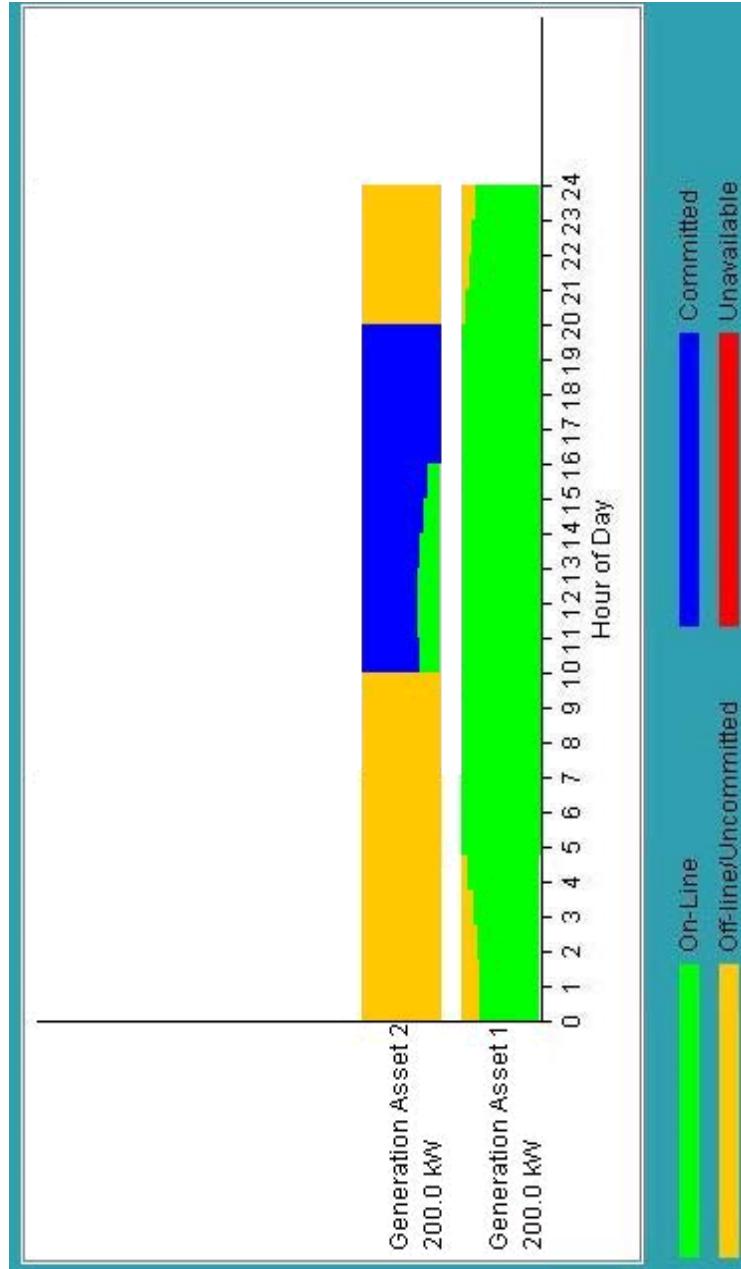
Smart* DER Based Aggregation



Pier Smart*DER Schedule Generation

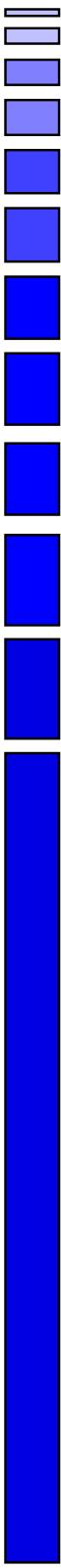


*Smart*DER Operating Schedule -
Excess Capacity Bid into AS Market (blue)*





PIER Benefits to California Ratepayers



This project will benefit California electricity ratepayers by meeting the following PIER goals:

- Improves the reliability and quality of California's energy system.
 - Enables the use of dispersed generation.
 - Enables rapid dispatch of generation and load reduction.
- Improves the energy cost and value of California's electricity.
 - Optimizes participation and competition in the electricity market, leading to lower prices.



Making the Market Connection



- Changed behavior of the ISO to post data in a consistent manner. Prior to this project there was no requirement for consistent posting of market information.

- These companies have expressed interest in using agents in conjunction with their products to schedule DER:
 - Engage Energy
 - 6th Dimension
 - Enflex
 - Connected Energy
 - Encorp



Load Reduction Switch and Grid Infrastructure Protection

California State University, Chico

Research Foundation

Contract No.: 500-00-008

Contract Amount: \$800,000

Mark Rawson: PIER Contract Manager

Problem Addressed



■ Rolling Blackouts

- Response to Stage 3 power emergencies
- Public safety equipment affected
- One-half of state exempted

■ Grid Protection

- Terrorists could easily disable grid using trucks/bombs
- Substations, power plants & transmission towers vulnerable
- Law enforcement/security cannot disable hijacked trucks

Project Purpose



- Develop and test technologies to ensure grid reliability

- Load Reduction Switches (LRS)

- » Meter Socket Configuration
- » Distribution Transformer Configuration
- Grid Infrastructure Protection Systems
 - » Truck Stopping Devices (TSD)
 - » Portable Truck Barriers

The Research



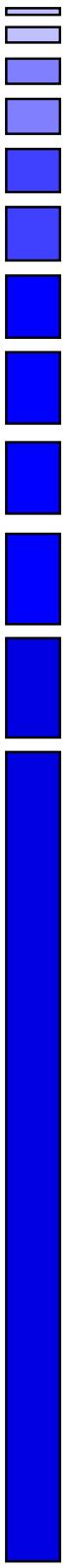
■ Load Reduction Switches

- *Concept:* Disable residential 240V appliances
- *Approach:* Device installed at meter socket or distribution transformer parallels +120V & -120V service legs

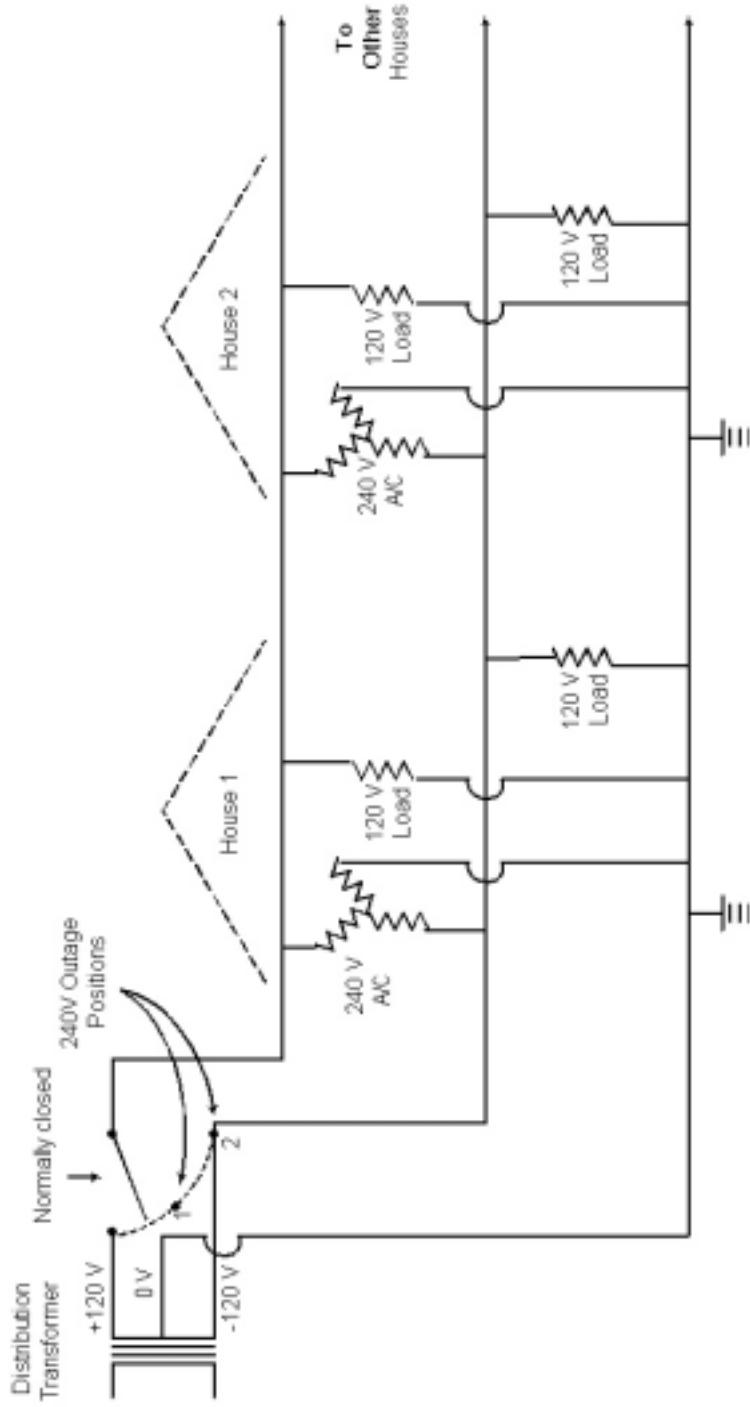
■ Grid Protection Systems

- *Concept:* Use portable truck barriers & trucking stopping system to secure sensitive grid infrastructure
- *Approach:* Device disables air brake system on truck trailers once inside secured areas and barriers for “runs at the gate”

How LRS Works



Wattenburg Switch Concept



Modes of Operation:

Mode 1 --- The switch is opened to the 1 position and the +120 V leg is opened.

Mode 2 --- The switch is opened to the 2 position and the +120 V leg is paralleled to the -120 V leg.

Project Objectives



The Objectives of the project are to:

For Load Reduction Switches, determine impacts of:

- Opening one hot leg of 240V service on appliances and equipment

– Connecting both legs of service to one side of transformer

– Doing above to a household and group of households

For Grid Protection Systems, develop:

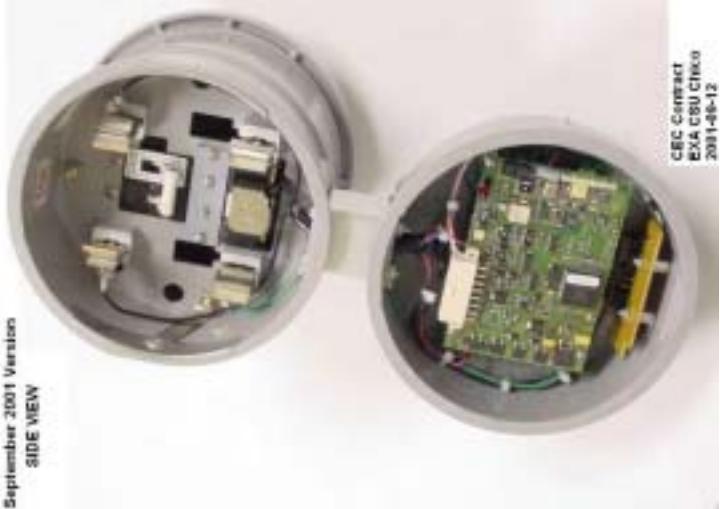
- Remote-controlled TSDs
- Control area protection system for activating TSDs
- Portable truck-stopping barriers

LRS & TSD Devices



LRS Prototype

Prototype Meter Based Load Reduction Switch
September 2001 Version
SIDE VIEW



CBC Contract
EXA CSU Check
2001-08-12

TSD Prototype



Benefits to CA Ratepayers



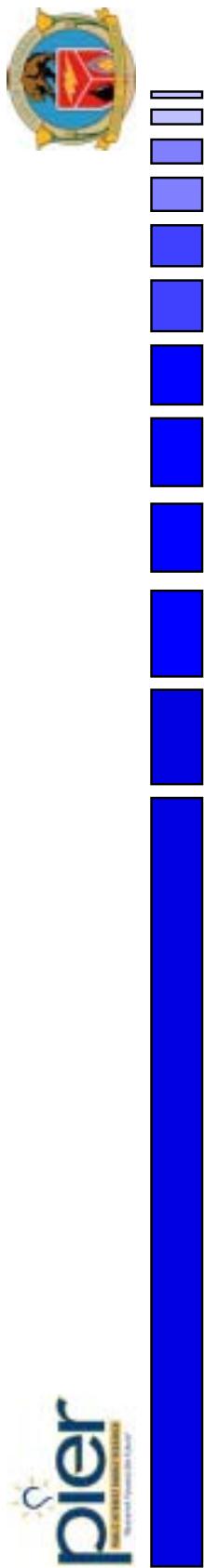
- This project will benefit California electricity ratepayers by meeting the following PIER goals by:
 - Improving reliability/quality by preventing or reducing impact of outages
- Other Benefits:
 - Shares the “wealth” of blackouts - equity issue
 - Addresses terrorist threat to grid infrastructure

Making the Market Connection



Ribbon cutting for truck stopping device
hosted by Governor's Task Force and
attended by Tom Ridge, Director of
Homeland Security





ELECTRIC SYSTEMS INTEGRATION

Airport Solutions Tailored Collaborative

Contractor: EPRI/NEETRAC

Contract # 100-98-001

Project Amount: \$91,500

McKinley Addy - PIER Project Manager

Problem Addressed



- Aviation is a key sector of California's economy with important consumer, energy and air quality impacts.
- Airport operations expanding to meet increasing air travel demand are emission point sources subject to regulation by air quality agencies.
- Electrification of airport operations as a solution to airport emissions can have potential adverse impacts on electric system power quality and stability with safety and economic implications.

Project Purpose



- The ESI-funded EPRI Airport Solutions project explores and sponsors airport electrification solutions that save energy and reduce emissions.
- Understand the impacts of electric ground support equipment and aircraft gate electrification on power system quality and reliability.
- Enable the capture of the public benefits of cleaner air, higher energy efficiency and lower operating costs for airlines and consumers.
- Recommend electrification levels at airports for the subject applications.

The Research



- Assess the power quality impacts at 5 airports under 5 tasks.
- Airports: Sacramento (SMF), San Francisco (SFO), Orange County (SNA), Los Angeles (LAX), and Dallas/Fort Worth (DFW)
- TASKS: Collect airport data, Develop PQ assessment model, Conduct case studies, Report findings and disseminate through tech. transfer.
- Research done by Georgia Institute of Technology's National Energy Testing Research & Applications Center (NEETRAC)

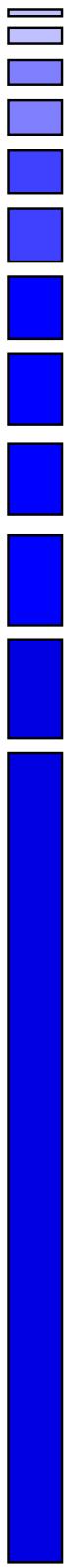
Project Objectives



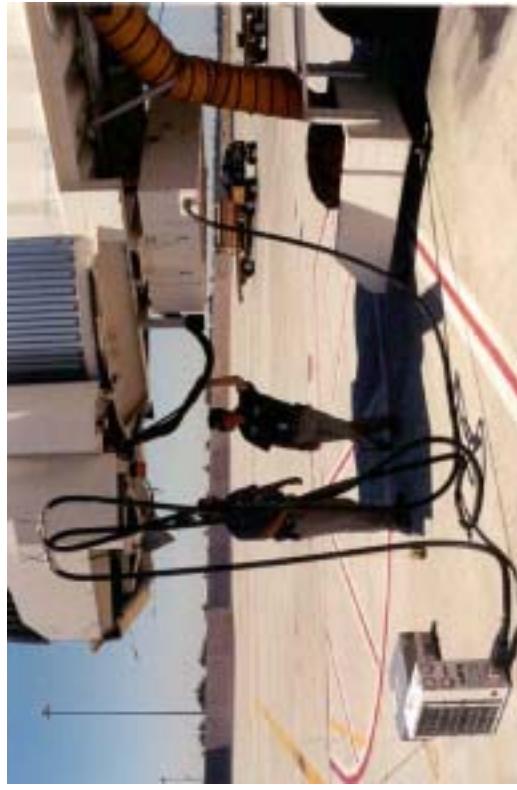
- The objectives of this project are:
 - Develop a model for assessing power quality impacts at airports
 - Determine levels of airport gate and ground support electrification that will not adversely impact power quality at airports.
 - Disseminate the findings to policy makers and stakeholders (airports, airlines, electric utilities, air quality management agencies, GSE charger manufacturers)



Electric Gate Equipment



PWM-90 Jet Power
400 Hz System - SMF

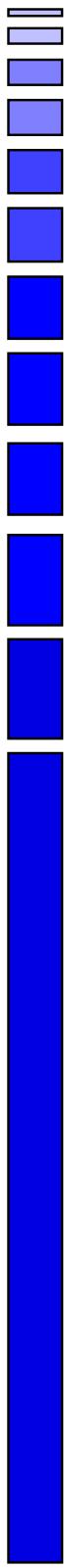


XPC-3000 Jet Aire
PC Air System - SMF



I _{rms} (A)	Power (kW)	%THD _i	True PF*	I _{rms} (A)	Power (kW)	%THD _i	True PF*
134	103.5	6	.93	87	62.2	3	.85

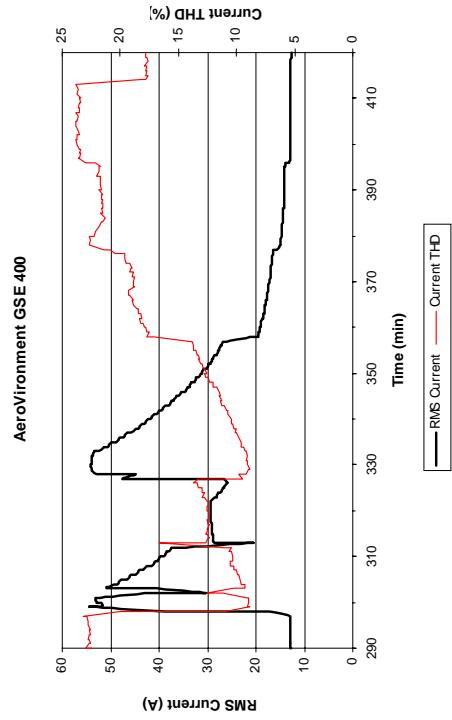
Charger Technology



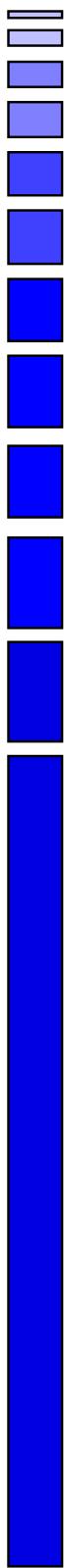
AeroVironment Fast
Charger at American
Airlines - DFW

Charger PQ performance
parameters

I_{TRMS} (A)	Power (kW)	%THD _i	True PF*
52	42.4	9	-.97



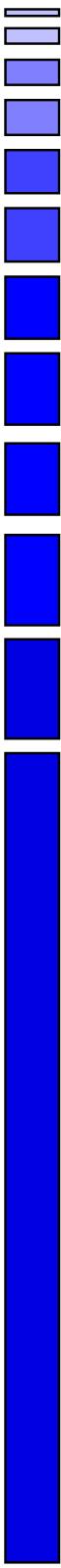
Benefits to CA Ratepayers



- This project will benefit California electricity ratepayers by meeting the following PIER Goal(s):
 - assuring the Reliability/Quality of California's Electricity
 - using California electricity to improve the environmental and public health by avoiding adverse electric system impacts, reducing emissions from airport operations
 - using California electricity to lower the operating cost to airlines and travel costs of consumers by improving energy efficiency



Pier Making the Market Connection



- A technology transfer activity occurred on October 3, 2002 with the presentation of project findings at the EPRI workshop during the GSE conference.
- Sacramento International Airport is using the results of this research to insure adequate GSE and gate electrification capacity during the renovation of Terminal B, and the implementation of its \$2 million ILEAV Program.

PIER Energy Systems Integration, Technical Review November 21 and 22, 2002

Completed Projects

Project Title: Electric System Seismic Safety and Reliability

Contract: 500-97-010

Contractor and Major Subcontractors: Pacific Gas and Electric Company and University of California, Berkeley Pacific Earthquake Engineering Research Center (PEER)

Contract Amount: \$1,000,000

Contractor Project Manager: Dr. William (Woody) Savage (415) 973-3116

Commission Contract Manager: Robert Anderson (916) 654-3836

Publication Number: P600-00-031

Project Description: The purpose of this project is to support several major research projects in the field of electric system seismic safety and reliability. Projects ranged from the shake table testing of electric bushings and the collection of soil data at existing substations, to the development of a rapid response, strong ground shaking contour map program and related strong ground motion attenuation curves. Some of the early products have already been incorporated by a major California utility in their risk management practices. This contract was extended through January 31, 2000, due to the interruption of research report preparation by investigators assigned to assess damage in Turkey after the August 17, 1999, magnitude 7.4 Kocaeli earthquake.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing the vulnerability of the electric transmission and distribution system due to damage caused by a major earthquake, continuation of power in an area affected by an earthquake and/or by the rapid recovery of the electric service. This rapid recovery will allow for a shortened interruption to emergency services and businesses due to the loss of electric power.

Proposed Outcomes:

- Improvements to installed utility equipment will be identified and tested, and the potential for future disruptions due to earthquake-induced damage can be reduced.
- Develop improved assessments of shaking-caused permanent ground deformation hazards in formats that the utility can directly use for evaluating electric system vulnerabilities.
- Examine the process of fire initiation during power restoration following earthquakes to evaluate various means to reduce the risk of starting fires.
- Develop the capability to analyze data from distant seismographic instruments to accurately predict the pattern and severity of strong earthquake shaking anywhere in the state.

Project status: The project is on schedule, within budget and is expected to achieve the proposed outcomes.

Project Title: Dynamic Circuit Thermal Line Rating (DCTR)

Contract: 500-97-011

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$110,000

Contractor Project Manager: Bill Torre (619) 696-4880

Commission Contract Manager: Linda Davis (916) 654-3848

Publication Number: P600-00-036

Project Description: The purpose of this project was to develop and demonstrate real-time transmission line ratings. DCTR uses equipment mounted on a transmission tower to monitor the line conductor tension and determine ground clearances and weather conditions to calculate the amount of current that can be transmitted in real time. This information is provided to system operators or engineers for their use in safe, reliable and economic system operation. Conventional transmission lines ratings have been established as static rating, which may be lower than the maximum capability of the conductor. By monitoring wind speed, conductor tension and solar heating, a real time line rating may be calculated that is closer to the maximum conductor capability.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity since using real time dynamic line ratings ensures reliability and quality by making sure that ground clearances are not exceeded thus avoiding contact and flashovers which cause power outages and voltage surges;
- Improving the energy cost/value of California's electricity by improving transmission line utilization to facilitate economic transactions and reduce costs as real time ratings allow greater power transfers on existing facilities than the static line rating;
- Improving the environmental and public health costs/risks of California's electricity by improving utilization of existing transmission lines thereby avoiding the need for new lines and the associated environmental impacts; and
- Improving the safety of California's electricity by using real time information to make certain that ground clearance limits are not exceeded thus avoiding the risk of electrical shock and fires.

Proposed Outcomes:

- Increase transmission capacity on congested transmission lines to allow increased power transfers.
- Reduce use of expensive generators which "must run" due to transmission rating constraints.
- Promote the use of more economic generators to result in reduced energy system price for utility customers.

Actual Outcomes:

- The dynamic real time rating for the demonstration was up to 150 percent more than the normal rating at some times. From 9 a.m. through 5 p.m., the dynamic rating averaged a 75 percent increase in rating over the normal rating on that circuit.
- The real time rating also indicates that line ratings are sometimes reduced, and eliminates the risk of sagging the conductor to the point of contact thus preventing danger to the public.

**Project Title: System Stability and Reliability: Flexible AC Transmission Systems (FACTS)
Benefits Study**

Contract #: 500-97-011

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$100,000

Contractor Project Manager: Abbas Abed (619) 696-2755

Commission Contract Manager: Linda Davis (916) 654-3848

Publication Number: P600-00-037

Project Description: This project investigated the feasibility and benefits of implementing Flexible AC Transmission System (FACTS) devices on Extra High Voltage (EHV) electricity transmission lines to increase power transfer capability and electricity import capability. The use of Static Condensers (STATCON), Thyristor Controlled Series Capacitors (TCSC) and Static Var Controllers (SVC) were examined in this previous study.

To meet the forecasted future electrical load in California, either additional generation must be installed or import capability must be increased. FACTS technologies help improve power transfer, power quality and system control. FACTS technologies use high-speed, thyristor-controlled devices and advanced control concepts to allow loading lines to their thermal limits without compromising system reliability. This study conducted detailed technical and economic studies to investigate the benefits of FACTS technologies for the SDG&E service territory.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by allowing operators to load lines to their thermal limits without compromising system reliability;
- Improving the energy cost/value of California's electricity by improving the efficiency of the power transfer capacity of the electricity transmission system; and
- Improving the environmental and public health costs/risks of California's electricity by improving the power carrying capability of the existing system thereby reducing the need for new transmission lines.

Proposed Outcomes:

- Conduct detailed technical and economical studies to investigate the benefits of Flexible AC Transmission Systems (FACTS) devices located in SDG&E's service territory. The study focus was on the potential benefits of existing and new FACTS devices in improving SDG&E's import capability.

Actual Outcomes:

- Preliminary studies show that facility overload and reactive power deficiency are the main problems associated with increasing SDG&E's import capability.
- FACTS technology can be used to mitigate both problems and could possibly increase SDG&E's simultaneous import capability by 300 MW by relieving line overloads and providing dynamic reactive power support.
- FACTS also could possibly increase non-simultaneous import capability by 250 MW by relieving line overloads and providing dynamic reactive power support.
- The system transfer capability increases can also be achieved through rearrangement of transmission circuits at lower cost than the FACTS technology.

Project Title: Phasor Measurement Units

Contract #: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$150,000

Contractor Project Manager: Mohan Kondragunta (626) 815-0507

Commission Contract Manager: Linda Davis (916) 654-3848

Publication Number: P600-00-019

Project Description: This project demonstrated real-time monitoring and potential of future control of the Western Systems Coordinating Council (WSCC) electric power grid using Phasor Measurement Units (PMUs), which are low-cost sensors that measure voltage, current phase angles and magnitudes that are time tagged for relative comparison between geographically distant locations in Southern California and Oregon.

The PMUs communicate real-time data to a Phasor Data Concentrator (PDC) at very high speed using communication systems from all the monitoring sites. The system will allow various energy control centers and systems to monitor the entire WSCC system and will help to provide information to prevent wide scale power outages. The project will develop a system to pool data from all major WSCC members and make it available to all participating members for post-disturbance analysis.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by allowing regional energy control centers and systems to monitor the entire WSCC system; and
- Improving the energy cost/value of California's electricity by reducing wide scale power outages.

Proposed Outcomes:

- Develop a system that facilitates real-time monitoring of regional transmission facilities.
- Low-cost sensors and software were to be developed for use with a high-speed communication system that allows utilities and eventually regulators to monitor the status of regional transmission and distribution lines.

Actual Outcomes:

- Two PMUs installed in Southern California Edison (SCE) with communication systems resulted in data collected at a very high speed from all the monitoring sites for viewing grid disturbance data of the Bonneville Power Administration in Oregon at SCE in Southern California.

Project Title: USAT MOD-2

Contract #: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$1,000,000

Contractor Project Manager: Bob Yinger (626) 815-0508

Commission Contract Manager: Linda Davis (916) 654-3848

Publication Number: P600-00-020

Project Description: The purpose of this project was to promote development of the USAT satellite communications system to deliver high-reliability communications for utility supervisory control and data acquisition (SCADA) systems under all types of weather conditions. SCADA systems allow a utility to monitor and control its transmission and distribution system to insure high reliability. Traditionally, communications was accomplished by leased or private telephone lines, microwave, fiber optic cable or radio. The use of satellite communications needs to be very cost effective in remote areas and capable of collecting high speed SCADA data from any location in California no matter how remote. This data would not be available if conventional communications technologies were used.

This SCADA data is valuable in insuring that the highest reliability is maintained for the California transmission and distribution systems by enabling real-time monitoring of system loading and quick execution of control commands during normal and emergency conditions. Because of the system's high reliability and "communications anywhere" capability, it is invaluable during major fires, storms and earthquake emergencies. Communications during these emergencies is valuable in locating problems, assessing damage and returning equipment to service quickly. The ULTRA-NET™ remote terminals are easily installed and can be in service within a few hours to help reduce restoration time after a catastrophic event.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by providing accurate electric grid monitoring information on power supply disruptions;
- Improving the energy cost/value of California's electricity by reducing maintenance costs and restoration time;
- Improving the environmental and public health costs/risks of California's electricity by eliminating the need for service vehicles to visit remote sites on a regular basis. [This will result in a reduction of over 3 million vehicle miles (250 to 500k miles per year) resulting in fuel conservation and a corresponding reduction in environmental pollution]; and
- Improving the safety of California's electricity by allowing communications to be restored quickly when the infrastructure for other systems has been damaged or during catastrophic events.

Proposed Outcomes:

- Deliver high-reliability data between SCADA systems of electrical transmission and distribution systems under all types of weather conditions using satellite communications that are cost effective in remote areas.
- Develop a satellite communications system capable of collecting high speed SCADA data from any location in California no matter how remote to make data available beyond that of conventional communications technologies and enabling real-time monitoring

Actual Outcomes:

- ❑ The system operated successfully, but more field operation is required before it can be considered a commercial product.
- ❑ To increase the commercial potential of the system, the cost of the remote terminals needs to be reduced since many remotes and only one hub is required in a complete system.
- ❑ Restoration time for communication to remote areas can be greatly improved since conventional restoration can take days, while the restoration of communications with USAT is accomplishable within hours.

Project Title: Energy Source Stabilizer (ESS)

Contract: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$250,000

Contractor Project Manager: Mohan Kondragunta (626) 815-0507

Commission Contract Manager: Linda Davis (916) 654-3848

Publication Number: P600-00-021

Project Description: This project developed and demonstrated an Energy Source Stabilizer (ESS) that functions through a generating machine governor or other electronics-controlled power device to stabilize electrical frequency oscillations between various areas. Inter-area oscillations can cause very wide spread and costly power outages that may last for many days. Control of these dynamic oscillations through the generating machine governors is more effective and inexpensive than the existing power system stabilizers that function through the generating machine excitation system. Once proven, the ESS units can be installed on all generating machines having state-of-the-art rapid response governors.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing the incidence of large-scale power outages; and
- Improving the energy cost and value of California's electricity by providing a low-cost means of improving system reliability.

Proposed Outcomes:

- Stabilize low frequency dynamic system oscillations by modulating the real power of generators, thereby improving system stability and reliability.

Actual Outcomes:

- Two Energy Source Stabilizers (ESS) were installed at Alamitos Generating Station in Southern California and ESS performance was monitored during system disturbances to validate the working of ESS.
- The ESS operated as expected to dampen oscillations that otherwise may have increased to cause a widespread power outage.
- Multiple ESS units need to be installed throughout the Western Systems Coordinating Council (WSCC) system to achieve the reliability benefits possible with this technology. It is estimated that the increase in energy import capability due to the reliability improvements of installing ESS can save California electric customers approximately \$15-20 million per year.

Project Title: Substation Reliability**Contract #:** 500-97-012**Contractor:** Edison Technology Solutions (ETS)**Contract Amount:** \$215,000**Contractor Project Manager:** Alonso Rodrigues (626) 302-8423**Commission Contract Manager:** Linda Davis (916) 654-3848**Publication Number:** P600-00-022

Project Description: The purpose of this project was to develop an intelligent alarm analysis and diagnostics system, the Alarm Analyzer. The system simplifies thousands of pieces of information and alarms during an emergency condition, such as a regional system breakup due to a fault. In a matter of seconds, the operator is presented with only the relevant and highest priority information on system status and a recommended course of action. This compares to hours or days to do the same manually.

Voice data and command entry is established in control room consoles. During system disturbances, switching and other load and grid operations must be executed quickly and accurately. Speech recognition tools being adapted and evaluated through this project will free the operator from the keyboard to permit data entry and commands by voice. This project improves substation system efficiency, reliability and capacity and reduces operation and maintenance costs. This project helps electrical system operators to provide a much quicker response time during transmission system breakup and disturbance.

The Alarm Analyzer improves the accuracy of control room operator decisions by assisting in quickly identifying the type of fault and accurately identifying its location. This information is essential in reducing the amount of outage time and costs to the users and the utilities. Crews can be dispatched with the correct materials for repairs to the precise trouble location and system reconfiguration can be implemented immediately to restore service through alternate routes.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing restoration and fault analysis time from hours or days to minutes;
- Improving the energy cost/value of California's electricity by reducing operations and maintenance costs; and
- Improving the environmental and public health costs/risks of California's electricity by reducing the risk of operation mistakes during power disturbances.

Proposed Outcomes:

- Complete the initial stage of development of an intelligent alarm analysis and diagnostics system to automatically classify and filter the thousands of pieces of information and alarms generated during an abnormal event on the grid, such as a regional blackout caused by a fault.
- Investigate the feasibility of the Alarm Analyzer tool.
- Implement voice recognition technology and evaluate its benefits in the entry of data and commands into a computer or other device in control rooms and other applications.

Actual Outcomes:

- Southern California Edison (SCE) completed its objectives by developing the Alarm Analyzer tool, implementing voice recognition technology, and conducting successful demonstrations of each.

- Use of the Alarm Analyzer tool reduced the time required to produce an accurate diagnostic of an event from several hours or days to less than two minutes. These results are based on simulations of actual events occurring at the Dalton Substation.
- The voice recognition tools evaluated in this project resulted in a productivity increase of at least 200 percent in entering information into a computer file, with an accuracy rate greater than 97 percent. These results are based on a comparison between keyboard entry methods and voice input.
- Operations and maintenance costs are reduced by improving productivity through data entry and control of computers via voice. Dictating directly to the computer was found to improve productivity by at least 200 percent and greatly simplified multi-tasking for control room operators, line patrols, and office personnel.

Project Title: Development of a Composite Reinforced Aluminum Conductor

Contract #: 500-98-035

Contractor and Major Subcontractors: W. Brandt Goldsworthy & Associates, Inc.

Contract Amount: \$75,000

Match Funding: \$185,000

Los Angeles Regional Technology Alliance \$65,000

DOE-Energy Inventions and Innovations \$55,000

WBG&AI \$65,000

Contractor Project Manager: W. Brandt Goldsworthy (310) 375-4565

Commission Contract Manager: Linda Davis (916) 654-3848

Publication Number: P600-00-040

Project Description: The purpose of this project is to improve the reliability and capability of California's transmission and distribution system by developing a stronger and lighter conductor to replace these aging and overloaded power lines. Specifically, this project will develop a composite reinforced aluminum conductor (CRAC) to replace conventional conductors made from aluminum wires wrapped over a core of steel strands (called aluminum conductor - steel reinforced (ACSR) conductors). Many miles of California's overhead electricity transmission lines have reached the end of their service lives or are being stressed beyond their design limits due to load growth and heavy power transfers across longer distances. This technical development is very timely as the current age of transmission lines ranges from 30 – 70 years.

W. Brandt Goldsworthy and Associates, Inc. of Torrance, CA, with additional match-funding support from the DOE and private industry, is reconfiguring aluminum conductors around a lightweight composite strength member whose weight is approximately 25 percent of the traditional steel strength member. The resulting lightweight conductor can be optimized for reduced sag and increased ampacity. CRAC conductors can withstand adverse weather and high load conditions, thereby avoiding power outages caused by line sagging and swinging, high winds and ice buildup.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by avoiding power outages caused by line sagging and swinging, high winds and ice buildup;
- Improving the energy cost/value of California's electricity by reducing losses and the costs of replacing conductors;
- Improving the environmental and public health costs/risks of California's electricity by reducing the need for new transmission lines; and
- Improving the safety of California's electricity by significantly reducing the potential for line clearance violations.

Proposed Outcomes:

- Design, fabricate and test a robust, practical and cost-effective composite reinforced aluminum conductor.
- Target market price for CRAC is \$1.00 per product pound, which is approximately the cost of aluminum conductors which are steel reinforced.
- Five percent more electrical conductivity, compared to steel reinforced aluminum conductor
- Reduced mechanical elongation (line sag) at high operating temperatures
- 250 percent stronger than steel reinforced aluminum conductor
- 75 percent lighter than steel reinforced aluminum conductor

Actual Outcomes:

- Two CRAC, CRAC-121 (one-to-one) and CRAC-Advanced, were developed during this project. Both achieved:
 - Five percent more electrical conductivity than DRAKE.
 - A minimum of 40 percent more ampacity than DRAKE.
 - Twenty percent less mechanical elongation at ambient operating temperatures.
 - A 30 percent strength increase compared to DRAKE.
 - Only a 25 percent weight reduction was achieved and the objective of a 66 percent reduction was not met. In retrospect, this turned out to be an ill-posed objective because the maximum possible weight reduction, achieved by taking all the steel out of the DRAKE conductor, is only 33 percent.
- Splicing techniques were developed and demonstrated for both CRAC.
- A splicing tool was developed to splice the composite strength member.
- There were two very positive unanticipated outcomes.
 - CRAC conductors were found to operate 9 (CRAC-121) to 25 percent (CRAC Advanced) cooler than ACSR conductors.
 - Both conductor designs can carry optical fibers in the hollow center. When optical fibers are added, these conductors are called CRAC-TelePower.

Project Title: Target 1 Residential Heat Pump Technology

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; D.W. Abrams, P.E. & Associates; P.C.; OG&E Electric Services Company; Oregon Department of Energy; Saturn Resource Management; Southern California Edison Co.

CEC Project Amount: 1999: \$293,697

Match Funding: 1999: \$1,129,818

Contractor Project Manager: Carl Hiller, 530/758-3035

Commission Project Manager: Bill Pennington,

Commission Contract Manager: Gary Klein, 916/653-8555

Project Description: The purpose of this project is to support EPRI's continuing development of high-performance (energy efficient) heat pumps and their efforts to deliver quality data and services to invigorate the market. Working with manufacturers and research partners, EPRI is supporting production of climate-wise air and geothermal heat pumps, demonstrating heat pump applications, verifying performance and energy efficiency, and pursuing refinements to the "Insider" heat pump, a compact unit for multifamily and manufactured housing. This target also delivers products on duct system design and duct sealing technology to further reduce energy waste, and collaboration on a national technician certification program to address installation and customer satisfaction issues.

EPRI's collaborative program impacts technology development and heat pump infrastructure nationally. This, in turn, benefits California users to ensure a continued positive market environment for residential heat pumps. The Commission will receive technical information and persuasive promotional materials for local educational activities to stimulate residential customer's interest.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by developing and enhancing the performance and efficiency of residential heat pump technology to reduce the energy needs for space heating and cooling applications; and
- Improving the environmental and public health costs/risks of California's electricity by reducing energy use, which in turn decreases power generation emissions, and by supporting the changeover from ozone deleting refrigerants to Zero Ozone Depletion Potential (ZODP) fluids.

Proposed Outcomes:

1. Provide tools to increase the use of Zero Ozone Depletion Potential (ZODP) Refrigerants.
2. Provide tools to increase the potential for the use of Air-Source Heat Pumps.
3. Provide information to support market-ready enhanced, integrated heat pumps.
4. Develop a Technician Certification program to improve the likelihood of proper heat pump selection and proper installation.
5. Supply information to increase the potential for use of Ground-Source Heat Pumps (GHP).
6. Compile information to increase the potential for use of Thermal Distribution Systems Development and Applications.
7. Conduct a Tailored Collaboration entitled "Research on Heat Pump Performance Maps for Incorporation into Building Energy Analysis Calculation Methods" to develop improved calculation methods that permit more accurate comparison of standard air-source heat pumps and air conditioners with ground-source heat pumps.

Actual Outcomes:

1. Software and information were provided on the performance of zero ozone depletion potential refrigerants.
2. Air-source heat pumps.
 - Version 1.0 was released of EPRI's ESPRE for Windows, which can be used to analyze building energy use as a function of technology.
 - Version 3.0 was released of EPRI's Residential Desk Book, which offers a compendium of information of end-use residential technologies.
 - Brochures were published on dual fuel heating and cooling, sealing heating and cooling systems, and repairing leaky ducts.
 - A newsletter was published on heat pump developments, issues, and markets.
3. Integrated heat pumps.
 - Support was provided to the manufacturer of the PowerMiser integrated heat pump.
 - A brochure was published on marketing integrated heat pumps
 - A brochure was published on the Insider integrated heat pump.
4. EPRI assisted in the development of a comprehensive technician certification program, which merged the testing and certification programs of NATE, ACCA, and RSES.
5. Ground-source heat pumps (GSHPs).
 - A design and installation planning guide was published for GSHPs.
 - A directory was published of GSHP manufacturers and equipment.
 - EPRI hosted the 1999 GeoExchange Industry Conference and Exposition in Sacramento in September 1999.
6. A brochure was published on optimizing thermal distribution systems.
7. Detailed performance map data were collected on both air- and ground-source heat pumps for use in an upgraded analytical procedure to be used in California Title 24 residential building energy compliance evaluations. Several thousand performance maps were obtained, and recommendations were made on analytical procedure modifications.

Status:

The Commission's participation in this target ended as of December 31, 1999. Participation in the tailored collaboration ended December 2000.

Project Title: Target 7 Commercial Heat Pump/Air Conditioning Technology

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Lennox Industries; ClimateMaster, Inc.; Joint Center for Energy Management-University of Colorado; Alliant Energy; Bevilacqua-Knight Inc; Geothermal Design & Engineering, Inc.

CEC Project Amount: 1999: \$144,500

Match Funding: 1999: \$1,186,322

Contractor Project Manager: Mukesh Khattar, 650/855-2899

Commission Project Manager: Martha Brook

Commission Contract Manager: Gary Klein 916/653-8555

Project Description: The purpose of this project is to continue developing higher-efficiency, climate-wise refrigerants for the commercial heat pump and unitary air conditioner market. In California, this accounts for approximately one-third of the commercial sector's electricity use. Manufacturers are slowly developing electric equipment for the best refrigerants emerging from research. The slow pace of equipment development is a barrier to the broader use of commercial heat pumps. This project includes developing environmentally superior heat pumps, water-loop, and geothermal systems, and improving indoor air quality and dehumidification. The target also includes work on improved refrigerants and equipment to achieve greater comfort, lower noise, and lower capital and operating costs.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by developing and enhancing the performance and efficiency of heat pump technology for space heating and cooling applications; and
- Improving the environmental and public health costs/risks of California's electricity by reducing energy use which in turn decreases power plant emissions and supporting the changeover from ozone-depleting refrigerants to zero ozone-depleting (ZODP) fluids.

Proposed Outcomes:

1. Provide practical technical information to increase the market penetration of energy efficient heat pumps and new air conditioning technologies.
2. Support development and introduction into the market of commercial heat pump products with substantially improved comfort, efficiency, and environmental impact.
3. Support development and application of Water-loop and Ground-coupled/Geothermal Heat Pump (WL/GCHP) Systems.
4. Support development and application of energy efficient and cost-effective solutions to treat ventilation air and improve indoor air quality and dehumidification.

Actual Outcomes:

1. Technical information.
 - A status review report was published on EPRI commercial heat pump innovations.
 - Updates on industry news were published on refrigerant availability, refrigerant properties, and the ASHRAE 90.1 Standard.
 - The Geothermal Information Office provided information to EPRI members on the use of geothermal systems in commercial and residential buildings.
2. EPRI teamed with Lennox International to develop the first prototypes of Zero-Ozone Depletion Potential commercial rooftop heat pumps with 7.5 and 10-ton capacities. A lab test report was published.

3. Water-loop and ground-coupled heat pump technology.
 - EPRI sponsored development by ClimateMaster of a water-source air heat pump for conditioning of 100% make-up air. The design is more energy efficient than existing units and has features for improved occupant comfort.
 - An evaluation was made of variable pumping strategies and operation of the SmartLoop Controller in buildings with water-loop heat pump systems.
 - A field test report and a tech brief were published on results of energy performance monitoring of a geothermal heat pump in a quick service restaurant.
4. A report was published providing a summary of current and advanced strategies for designing HVAC systems to meet indoor air quality requirements.

Status:

The Commission's participation in this target ended as of December 31, 1999.

Project Title: Target 9 Commercial Building Thermal Storage

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Florida State Energy Center; University of Wisconsin

CEC Project Amount: 1999: \$40,000

Match Funding: 1999: \$268,999

Contractor Project Manager: Mukesh Khattar 650/855-2899

Commission Project Manager: Martha Brook

Commission Contract Manager: Gary Klein 916/6538555

Project Description: The purpose of this project is to continue developing and implementing thermal energy storage (TES) technology. TES is valued for its proven capacity to trim peak power costs and reduce chiller capacity requirements, often resulting in systems more economical overall than their non-storage counterparts. This can reduce California ratepayers' electric bills and stretch California electric generation capacity. The importance of these advantages is accentuated by the emergence of refrigerant phaseout issues and real-time pricing. Many customers with facilities well suited to thermal storage are hesitant to move ahead because TES is sometimes seen as an unknown technology.

This project focuses on development of easy-to-use controls for optimal system operation, new analysis methods and data to improve the use of thermal storage in conjunction with real-time pricing, and technology demonstrations to build confidence and use of the technology.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by through development and application of thermal energy storage systems, which can reduce energy bills of California ratepayers.

Proposed Outcomes:

1. Provide information to support the development, application, and commercialization of cool storage technology that is competitive with non-storage equipment in terms of efficiency and cost.

Actual Outcomes:

1. Information to support development, application, and commercialization of cool storage technology.
 - A white paper was published that presented an analysis of the impacts of flexible and real-time price scenarios on the design of thermal energy storage systems.
 - Initial results were published of a field demonstration of a Near Optimal Cool Storage Controller at FirstUnion Stadium in Philadelphia. These results can be used to analyze the viability of thermal storage for specific California sites.
 - An analysis was published of a capacity enhancement approach for chilled water thermal energy storage systems.

Status:

The Commission's participation in this target ended as of December 31, 1999.

Project Title: Target 28 Airport Solutions**Contract #:** 100-98-001 #1**Contractor and Major Subcontractors:** EPRI; Hawaiian Electric Company Inc; Carey Transportation; Henry C. Larry**CEC Project Amount:** 1999: \$64,000 2000: \$64,000 **Total:** \$128,000**Match Funding:** 1999: \$151,045 2000: \$277,565**Contractor Project Manager:** Layla Sandell 650/855-2756**Commission Project Manager:** McKinley Addy**Commission Contract Manager:** Gary Klein 916/653-8555

Project Description: The purpose of this project is to develop new environmental and energy technologies and apply existing technologies, such as electric vehicles, to airport infrastructure to reduce pollution and subsequent costs. In addition, the project will develop improvements to airport efficiency, productivity and safety. Commercial airports are microcosms of all sectors of the electricity marketplace, are major energy users, and are of vital importance to the economic health of their surrounding community. The contribution to local and regional economies from California's largest airports is hundreds of millions dollars every year. However, airports face new and ongoing challenges. Citizens in surrounding communities question the impacts of airports on their quality of life. Reducing overall pollutant emissions from airport facilities has become a high priority issue. These issues could limit airport growth and in turn impact local and regional economies.

Converting ground transportation and other airport equipment to electricity is one solution to these issues. Inside terminals, the installation of electrically powered equipment can improve indoor air quality, reduce HVAC system operating costs, and prevent disruptions in power quality-sensitive equipment. Outside terminals, the use of electrified equipment and vehicles can provide annual operating cost savings exceeding \$500,000. In addition, emission reductions of up to 80 percent could be expected at airports that convert much of their ground transportation and equipment to electricity. EPRI's Airport Solutions Target has developed the necessary methodologies and models to assess the feasibility of electrification and the associated economic and environmental benefits on an airport-specific basis. Through the development and deployment of electrotechnologies, sustainable growth of airports will be enhanced, and energy savings will be attained.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing information on efficiency improvements available for use by airports; and
- Improving the environmental and public health costs/risks of California's electricity by reducing emissions from the internal combustion engines used by airport facilities by encouraging replacement with electrically-powered equipment.

Proposed Outcomes:

1. Provide information on energy solutions to support the improvement and growth of California airports.

Actual Outcomes:

1. Information on energy solutions for airports.
 - EPRI organized a pioneering project to electrify American Airlines airport ground support equipment (GSE) at Detroit Metro Airport. This first-of-its-kind project electrified 132 pieces of

GSE by the end of 2000, and is scheduled to electrify the airline's entire fleet of 1070 vehicles over the next five years. Case study results were published.

- EPRI hosted an Electric Ground Support Equipment Market Penetration Issues Round Table in June 2000 in Sacramento, CA. The meeting brought together more than 40 representatives of California airports, airlines, vehicle and component manufacturers, a standards-making body, and utilities to address key issues. A proceedings of the meeting was published. A second round table was held in October 2000 at LaGuardia Airport.
- The latest information was received from the FAA's Inherently Low-Emission Vehicle (ILEV) pilot program, which seeks to achieve environmental benefits through the use of low-emission vehicles.
- A life-cycle cost-evaluation model and spreadsheet were developed to compare life-cycle costs of electric versus internal combustion-based GSE fleets under different scenarios of operation, thereby assessing the economic benefits of the cleaner airport vehicles.
- EPRI participated in the planning of a GSE Data Collection Project with Southern California Edison to meter equipment and collect performance, battery management, and metering data.
- EPRI participated in the planning of a 12-month Power Quality Impact Study involving the characterization of electric GSE charging systems.
- Information was provided on the environmental benefits of ozonation of cooling towers at an airport in Shreveport, Louisiana.
- EPRI participated in the National Electric Vehicle Association Infrastructure Working Council (IWC) GSE connector standardization meetings to develop functional specifications for electric GSE connectors, thereby providing a supporting infrastructure for electric GSE, and ensuring safety and reliability of fast charging.

Status:

The Commission's participation in this target ended December 31, 2000.

Project Title: Target 41 Opportunities in Networked Home Services

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Paragon Consulting (CA); EH Publishing; Levey Associates; Connect USA, Hoffman Publications; Macro Research; Web Wizard; Centermore Group, Collaborative.com; North-Atlantic Consulting; Phillips; Sony; WebTV; Meternet.

CEC Project Amount: **1999:** \$487,000

Match Funding: **1999:** \$741,045

Contractor Project Manager: Craig McAllister 650/855-1095

Commission Project Manager: Tom Tanton

Commission Contract Manager: Gary Klein 916/653-8555

Project Description: The purpose of this project is to help California ratepayers with telecommunication-based consumer electronics and Internet-based service opportunities related to energy usage, Internet billing, meter reading, appliance control, and energy information. California ratepayers need help to sort through the many choices, find current, accurate information and analyses and perspectives sensitive to energy issues - online, interactive and customized to their needs. This Target is designed to provide California ratepayers with these resources. This Target offers convenient and relevant technology surveillance services, coupled with interactive web-based access to specialists and experts inside and outside the utility industry.

Focus- and custom- EPRI analysis is provided in several key areas:

- Protocols and technical standards, converging technologies, and commercial activity in powerline, telephone, radio frequencies (RF) and cable media;
- Products and vendors of commercially available systems, including integration and management services;
- Projects, market assessments, and economic analysis.

EPRI supports implementation of practical solutions in several ways:

- Builder guidelines for new home networking (expanding on the growing service offering begun with HVAC and heat pump guidelines);
- Mobile and Internet connected networked home showcases;
- Energy Network Computer Information Network systems deployment projects.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by informing California energy users of new technologies and services to minimize use and cost of electricity and maximize value to the residential ratepayers.

Proposed Outcomes:

1. Provide market, technology, and business analyses to increase the potential of success of new products and services.
2. Provide Networked Home Centers test-bed facilities to increase likelihood of adoption in California.
3. Provide market, technology, and business analyses of Smart Appliances to bring benefits to California ratepayers.
4. Conduct a Tailored Collaboration entitled "Community Network Demonstration" to evaluate the response of an initial focus group of 100 households to low-cost, non-PC-based, consumer access to relevant energy and public benefit information and services.

5. Conduct a Tailored Collaboration entitled “Linked Infrastructure Security Initiative” to provide workshops and educational materials on designing, managing, and evaluating electronic infrastructure security programs for the energy industry.

Actual Outcomes:

1. Analyses of new products and services.
 - EPRI’s Home Automation Technology Surveillance service reviewed more than 1500 news releases, conference and meeting presentations, interviews, and markets analyses; wrote more than 400 item summaries; and collated and organized the summaries in three interest categories.
2. Networked Home Centers.
 - Draft floor plan and budget were developed for a Mobile Home Automation Demonstration Showcase. This mobile “home office” will demonstrate networking via the Internet, in-home utility controls, and multiple, switchable meters.
 - Reports were published on Project Res-IDENT and Community Networks.
3. Analyses of Smart Appliances.
 - Analyses of Smart Appliances were provided through one of the interest categories of EPRI’s Home Automation Technology Surveillance service (described above).
 - A report was published on residential gateways and controllers.
4. Plans were developed for a pilot project—the Jefferson Project in Clairemont, California—scheduled to be launched in 2000.
5. Tailored Collaboration on Linked Infrastructure Security.
 - Five workshops were organized and facilitated, included two general program workshops and targeted workshops on development of security policy and procedures, operating systems, and legal issues.
 - Educational materials were published, including a security primer, DCS/PLC primer, SCADA/EMS primer, guidelines document, and an industry strategy paper.
 - A password secured, members-only web site was established for information sharing.

Status:

The Commission’s participation in this target ended as of December 31, 1999. The Tailored Collaborations ended December 31, 2000.

Project Title: Target 49 Power Markets and Risk Management

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; The Brattle Group; L.R. Christensen and Associates; The Northbridge Group; Bechtel Group, Inc.; Energoprojekt Consulting SA; Laurits R Christensen Associates Inc; M.S. Gerber & Associates; Marketing Decision Research, Inc; Pattern Recognition Technologies; Strategic Decisions Group

CEC Project Amount: 1999: \$480,000 2000: \$336,000 **Total:** \$816,000

Match Funding: 1999: \$3,336,827 2000: \$4,366,045 **Total:** \$7,702,872

Contractor Project Manager: Art Altman 650/855-8740

Commission Project Manager: Richard Grix 916/645-4859

Commission Contract Manager: Gary Klein 916/653-8555

Project Description: The purpose of this project is to provide a means of understanding risk in the California energy market. Managing risk is a key to competitive electricity prices in California, but traditional analyses cannot accurately reflect the value of resources or risks in today's market. EPRI provides a unique and powerful framework—anchored in modern finance theory—for making decisions with less risk, avoiding huge losses and providing a more stable electricity price environment. EPRI's Electricity Book and other EPRI products extend this tool, and focus on other critical issues, such as forward price curves and ancillary markets. Classes, workshops, and interest groups help Commission staff use all of EPRI's risk management tools quickly and effectively.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by reducing the risk associated with large electricity transactions and providing a more stable California electricity market.

Proposed Outcomes:

1. Provide a comprehensive analysis tool to model the California electricity market and the risks associated with the market.
2. Provide tools to value the benefits and risks of energy market transactions.
3. Provide better Forward Curve estimates to improve energy users' decision making.
4. Provide better understanding of ancillary services.
5. Conduct a Tailored Collaboration entitled "Market Pricing and Market Structure Analysis" to identify critical market pricing and market structure issues within California's new competitive electricity market that influence new market entry and have a direct impact on system reliability.
6. Conduct a Tailored Collaboration entitled "Using Dynamic Simulation to Understand Power Plant Construction Cycles" to modify and enhance an existing simulation tool, which will allow the CEC to model the permitting and construction process and thereby obtain new information on the economics and dynamics of cycles in the building of electric generating capacity.

Actual Outcomes:

1. Analysis tool to model the electricity market.
 - Version 1.10 was released of EPRI's Energy Book System (formerly called Electricity Book), an integrated software package that provides the capability for calculating the value of generating units, and for measuring the risks of transactions. Separate modules are included for pricing and tracking wholesale energy transactions, valuing generation assets, designing retail products, and determining risk exposures.

- Training and user groups meetings were held.
 - A report was published on describing commodity prices in the Energy Book System.
2. Tools to value benefits/risks of market transactions.
- Version 1.10 was released of EPRI's Contract Evaluator software, which is designed to value and price wholesale energy transactions and to calculate exposures to wholesale energy markets.
 - Version 1.20 was released of Contract Evaluator, with enhancements that improve the accuracy and speed of the modeling of price movements for risk management and derivative contract pricing.
 - Version 1.10 was released of EPRI's Risk Manager software, which calculates overall portfolio risk based on exposures, market prices, and price volatilities.
 - Version 1.20 was released of Risk Manager, with enhancements similar to Contract Evaluator described above.
 - Two technical reports were published to assist planners in better measuring risks contained in assets and liabilities, and to understand and analyze the hedging strategies to lower those risks.
 - Five workshops were held on "Value and Risk Management."
 - A workshop was held on "Boom/Bust Cycles in the Power Industry: Power Generation Construction Cycles and Implications of Under- and Over-Building of Natural Gas-Fired Power Plants for Energy Markets and Plant Valuation." Presentations are compiled in a final report.
 - An EPRI Pricing Conference was held.
 - A newsletter was published on the latest EPRI software and tools for power markets and risk management.
3. Forward Curve estimates.
- A sophisticated suite of tools, methods, and training was provided to assist planners in estimating forward curve price levels and volatilities in California power markets. Chief among these was a report entitled *Forward Price Forecasting for Power Market Valuation*.
 - Specific methods were provided for estimating process parameters—including natural gas prices and loads—which are key inputs to price forecasting.
 - Follow-up advancements were developed for the Forward Curve tools, including a calculation tool for identifying the marginal cost of power at nodes on the California grid, new algorithms for modeling load uncertainty scenarios, and a prototype model to facilitate application of the *FastForward* tool.
 - An assembled package was published entitled "Guide to Process Parameter Estimation Tool Kit," which includes a CD and a collection of four stochastic process parameter estimation spreadsheets.
 - More than half a dozen introductory and advanced training workshops and user group meetings were held.
4. Ancillary Services.
- Measurement and certification tests were conducted at a host generator site. Findings provide insight into understanding methods for measurement and certification, as well as measured values of different ancillary services.
 - A report was produced on key concepts underlying price formation of ancillary services in deregulated markets.
 - A workshop was held on ancillary services pricing, market analysis, and operational issues.
 - Findings were published from a study entitled "The Gas-Electric Interface—A Regional Analysis," which characterized and interpreted announced capacity additions and determined the extent to which these additions are likely to lead to a net increase in gas consumption.
5. The tailored collaboration has not started, pending approval from the Commission.
6. The modeling tool was delivered and demonstrated to the CEC, and a written summary was presented.

Status: The Commission's participation in this target ended as of December 31, 2000. Participation in the Tailored Collaboration entitled "Market Pricing and Market Structure" is pending. Participation in the Tailored Collaboration entitled "Using Dynamic Simulation to Understand Power Plant Construction Cycles" is complete.

Project Title: Target 56 Grid Operations & Management

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; EPRI Conference Plan; ABB Systems Control; Bailey Network Management; Bonneville Power Administration; Cegelec ESCA Corporation; Decision Systems International; Duquesne Light Company; General Physics Corporation; General Reliability; Houston Lighting & Power Company; Incremental Systems, Inc.; Iowa State University; Kansas City Power & Light Company; KEMA Consulting, KEMA-ECC, Inc; Oracle Corporation; Pattern Recognition Technologies; Potomac Electric Power Company; Quality Training Systems; Siemens Energy and Automation, Inc.; Siemens/Empres; TU Electric Company; University of Liege; Utility Consulting International; V&R Company; Energy Systems Research; Warsaw University of Technology; Washington State University

CEC Project Amount: 1999: \$190,000 2000: \$180,000 **Total:** \$370,000

Match Funding: 1998: \$4,838,558 1999: \$4,739,264 2000: \$4,951,836 **Total:** \$14,529,658

Contractor Project Manager: Dan Sobajic 650/855-8537

Commission Project Manager: Don Kondoleon

Commission Contract Manager: Gary Klein 916/653-8555

Project Description: The purpose of this project is to support EPRI's collaborative program in Grid Operations and Management, which is developing new tools and information to ensure that the power grid will be a gateway to efficient competition and the key to customer satisfaction. EPRI provides tools and information that offer guidance on how to respond to demands to safely push more power through the system without jeopardizing system security. EPRI's products give system operators a clear view of real-time grid conditions, and allow them to make decisions that take into account maximum use of the grid as well as reliability of the system. Examples include vital resources to support operator training, real-time software for Energy Management System (EMS) control and operation, and seamless communication between Energy Management Systems and power plants.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity through innovative technologies, which help to balance the competing needs of maximizing the use of the grid while maintaining the security of the system: and
- Improving the energy cost/value of California's electricity by merging new tools for grid functionality with information for operating in the new competitive marketplace. EPRI technology development programs will help to increase transmission capacity across constrained interfaces, thus reducing grid-operating costs, while enhancing system security.

Proposed Outcomes:

1. Provide software, methods, and information to enhance the transaction management capabilities of transmission system operations, and to allow increased transactions without impact on security.
2. **Provide software, methods, and information to maximize energy transfers and increase energy flows across constrained interfaces.**
3. Provide software, methods, and information to increase the transmission system capacity.
4. Conduct a Tailored Collaboration entitled "EPRI Early Warning System Project" to identify and report Y2K anomalies and events in electric and natural gas operations from 12/31/99 through 1/4/00.

Actual Outcomes:

1. Transaction management

- Version 1.4 of the transaction management software Open Access Same-time Information System (OASIS) software was developed. A response was prepared to FERC Order 638 to enhance the functionality and performance of OASIS business practices.
 - A variety of open-system, standardized tools were provided that will permit the CA-ISO to implement advanced security applications without regard for existing proprietary databases. Tools include Version 1.0 of the Application Program Interface (API), which enables users to integrate applications from various sources, and a Topology Processor, which allows applications developed for planning environments to be integrated into operating environments.
 - Two reports were published on the Common Information Model (CIM), which provides a common language for information.
 - New graphical user interfaces were developed for existing grid operations applications to ensure they have a consistent look-and-feel.
 - EPRI's Operator Training Simulator was integrated with API and CIM to allow operators to be trained with CIM data.
 - Five restoration lessons were produced for the Emergency System Management and Restoration (ESMR) product.
 - A tri-annual newsletter was published on new software programs and methods for improved transmission grid operation.
 - A report was published summarizing grid operations and planning issues, needs, technological advances, and regulatory changes in the 2000-2005 time frame.
2. Increase power flows
 - Version 2.0 was released of EPRI's Transfer Capability Evaluation (TRACE) software, which allows system operators to determine the maximum number of simultaneous power transfers possible.
 - TRACE was integrated with IEEE PSADD Common format to support the latest version of Power Technologies' PSS/E data formats.
 - A TRACE training workshop was held.
 3. Increase transmission capacity
 - EPRI's Dynamic Security Assessment (DSA) software was made available. DSA allows operators to increase loading on constrained networks by calculating stability limits on-line in real time.
 - Two reports were published on DSA and Risk-Based Security Assessment.
 - Version 1.1 was released of EPRI's On-line Voltage Security Assessment (VSA) software, which allows system operators to increase power transfers across voltage-constrained networks by calculating voltage limits on-line in real-time.
 4. A web site was established and operated to communicate information about the actual operating experience of selected locations during the year 2000 rollover.

Status:

The Commission's participation in this target is ongoing. Participation in the tailored collaboration ended December 31, 1999.

Project Title: Target 57 Grid Planning & Development

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; California Institute Of Technology; Canadian Electricity Association; Carnegie Mellon University; Cornell University; ESEERCO; Harvard University; Honeywell Inc; Howard University; Iowa State University; Michigan Technological University; Mississippi State University; New Mexico State University; P Plus Corporation; Power Technologies Inc; PSERC; Purdue Research Foundation; Southern Company Services Inc; Texas Engineering Experiment Station; University of Washington

CEC Project Amount: 1999: \$180,000 2000: \$180,000 **Total:** \$360,000

Match Funding: 1998: \$4,838,558 1999: \$2,206,917 2000: \$2,282,943 **Total:** \$

Contractor Project Manager: Dan Sobajic 650/855-8537

Commission Project Manager: Don Kondoleon (916) 654-3918

Commission Contract Manager: Gary Klein 916/653-8555

Project Description: The purpose of this project is to help grid planners have ample lead-time to prepare for the occasional bulk power transfer. Presently, they are responsible for facilitating hundreds of electricity sales and purchases each day. Bids must be processed in near real time and congestion issues must be resolved on the fly. Grid planning is becoming increasingly complex and labor intensive. This situation is directly at odds with dwindling work forces and loss of experienced personnel and the public demand for lower cost energy. To address this situation, EPRI is providing advanced analysis tools and enhanced communication systems. EPRI's Grid Planning and Development program provides a comprehensive portfolio of technology solutions for coping with the short-, mid-, and long-term planning and design demands of a changing industry. While the industry continues to change, the need to deliver reliable economical power will not. This target delivers planning aids and operator-training tools that improve grid utilization, reduce operating costs, and ensure system security.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by developing advanced analysis tools and enhanced communication systems which will enhance grid planning in today's high transaction environment while maintaining system security; and
- Improving the energy cost/value of California's electricity by improving grid utilization and reducing operating costs through the development and application of advanced tools and communications systems.

Proposed Outcomes:

1. Provide software, methods, and information to increase the reliability of the California transmission grid.

Actual Outcomes:

1. Software, methods, and information to increase grid reliability.
 - Information was provided that will assist the CA-ISO and California energy companies in designing rates and measuring ancillary services. Detailed information was provided on measuring three ancillary services—regulation, load following, and black start—and on certification testing for black start.
 - Versions 5.0 and 5.1 were released of EPRI's Transmission Reliability Evaluation for Large-Scale Systems (TRELSS) Program, which allows grid planners to simulate outages and study their effect on system reliability after taking suitable corrective action.

- Version 1.2 was released of Composite Reliability Assessment by Monte Carlo (CREAM), which simulates the composite effects of generation and transmission outages.
- Two software programs were released, and two reports were published on, simulation of complex systems, including a report on prototype intelligent software agents for trading electricity.
- A methodology was produced for evaluating short-term risk in power system planning in the presence of load forecast and fuel price uncertainty.
- Tools were developed to evaluate the annual production cost of electricity as a function of uncertainty in generator availability.
- Version 5.2 was released of EPRI's Small Signal Stability Program (SSSP), which identifies the causes of power system instability and pinpoints the location of technologies to mitigate the problems.
- Version 5.2 was released of EPRI's Voltage Stability Program (VSTAB), which determines areas that are prone to voltage instability.
- Version 5.2 was released of EPRI's Dynamic Reduction Program (DYNRED), which reduces large power system models to lower-order models that retain the characteristics of the original models while significantly reducing the computer time required to perform studies.
- The Common Information Model (CIM) was extended to planning applications, enabling planners to base their studies on operating data and to more closely cooperate with CA-ISO operators.
- Version 5.2 was released of EPRI's Extended Transient Mid-term Stability Program (ETMSP), which allows CA-ISO to conduct mid-term simulations for nonlinear stability analysis of the power system.
- The Off-Line Transfer Capability Evaluation (TRACE) software program was released, and a training workshop was held. This program will allow CA-ISO to increase transmission service revenues by accurately determining the maximum available transfer capability.
- A tri-annual newsletter was published on new software programs and methods for improved transmission grid operation.
- A workshop was held for regional transmission organizations (RTOs) and independent system operators (ISOs), and proceedings of the workshop were published.

Status:

The Commission's participation in this target ended December 31, 2000.

Project Title: Target 61 Knowledge-Based Customer Metering; 61.1 Technology Development; and 61.2 Market Research and Services Development

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Advanced Systems Associates; Hypertek, Inc.; Plexus Research Inc; Advanced Systems Associates; Arizona State University

CEC Project Amount: 1999: \$266,500

Match Funding: 1999: \$1,165,930

Contractor Project Manager: Dave Richardson 650/855-2331

Commission Project Manager: Tom Tanton

Commission Contract Manager: Gary Klein 916/653-8555

Project Description: The purpose of this project is to provide electricity consumers with intelligent, time-of-use electric meters with built-in communications to enable utilities and their customers to utilize innovative activities such as automatic meter reading and energy utilization analysis. An important part of industry restructuring is customization of service—providing new choices and new benefits to individual clients. Some customers may be attracted by new ways to lower their electricity bills, while others are already demanding premium power quality. Beyond the differentiation of electricity service, new opportunities are also arising for convergence of multiple utility services—including gas, telephone, home security, and Internet access—through a single provider. In each of these areas, more sophisticated customer interface technology will be needed to meet the data collection and communications requirements of the utility service revolution with customers and suppliers benefiting from detailed load and billing information.

New meter technology applications are being developed using the EPRI collaborative research approach to reduce development costs and risks. New products developed during these projects will be available to members for beta testing and at preferential pricing when the product has been commercialized. A prepayment meter is under development to give customers the flexibility of prepaying specific sums, just as telephone cards are now doing. A non-intrusive appliance load monitoring (NIALMS) module will be developed to provide a better understanding of residential energy usage leading to improved time of day pricing service. Tamper detection and research hold out the promise of reducing the number of billing irregularities. This EPRI target also develops market research into new metering service packages. Members will have an opportunity to participate in the research and select the target customers and demographics. Market data and analysis developed during these projects will be available to members for early adoption.

This project supports the PIER Program objectives of:

- Improving the quality of California's electricity by providing advanced meters with the intelligence, flexibility, and communication capability to allow automated meter reading, real-time pricing, and energy management services; and
- Improving the energy cost/value of California's electricity by enabling the delivery of value-added electricity services to customers through advanced meters.

Proposed Outcomes:

1. Produce a commercial product—the SE-240 electronic residential meter—which is cost competitive with existing meters on an evaluated basis, while providing an array of additional services.
2. Develop information on residential customers' responses to new types of services made possible by advanced meters and communications systems.

3. Develop information on metering technologies and their applications to provide maximum choice and value to customers.

Actual Outcomes:

1. SE-240 electronic residential meter.
 - Prototypes of the meter were field-tested by 47 utilities, and 19 vendors were engaged in the manufacture of plug-in modules. A technical progress report was published.
 - A prototype meter was released with an internal disconnect switch to be used for remote disconnect to prevent lost revenue.
2. Information on customers' responses to new services.
 - A comprehensive review was published of available information on prepayment metering in North America, including business issues, customer acceptance, regulatory issues, and available products.
 - A report was published identifying new energy services being offered today in residential and commercial markets by electric utilities and energy service companies.
3. Information on metering technologies.
 - Up-to-date information on business issues and technology developments was compiled on the Metering Industry and Product Development web site.
 - Field audits were conducted and a report published on metering revenue losses due to theft, meter misinstallation, and meter malfunction.
 - Support was provided to national standards setting organizations for open architecture for metering design. The minutes were published of the ANSI C12 Committee Meeting.

Status:

The Commission's participation in this target ended as of December 31, 1999.

Project Title: Target 91, Air Toxics Health and Risk Assessment

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Atmospheric & Environmental Research Inc; Exponent Failure Analysis Associates; Golder Associates Inc; ICF Kaiser Engineers; Lockheed Martin Energy Systems Inc; Raptor Research Project; SCOPE; Tetra Tech Inc; University of Connecticut; University of Maryland; University of Nevada, Reno; University Of Rochester; Wisconsin Department of Natural Resources

CEC Project Amount: 1999: \$507,250

Match Funding: 1999: \$3,233,763

Contractor Project Manager: Leonard Levin 650/855-7929

Commission Project Manager: Obed Odoebelam

Commission Contract Manager: Gary Klein 916/653-8555

Project Description: The purpose of this project is to determine whether trace substances emitted by power plants may be deposited near the emissions sources or be transported over great distances. At issue is whether power plant contributions pose concerns for human health and environmental quality. Currently, air toxics such as dioxins, arsenic, nickel, and especially mercury are of growing regulatory, public, and economic concern. Recent U.S. EPA reports to Congress address the relationship between these toxics and power plant emissions, and call for extensive research into several key questions: How toxic is the material emitted by power plants? To what extent, and by what means, are people exposed to that material? How can a realistic estimate of quantitative risk be derived? What risks are significant? Basic scientific understanding of these issues is critical to the energy industry.

The primary focus of this EPRI target is filling gaps in scientific and health information. EPRI research is designed to inform energy companies and policy-makers of the health and environmental basis for potential risks associated with air emissions and, when appropriate, to examine practical management solutions. This target, combined with the other EPRI research on air toxics measurement and control, provides a total integrated response to the issues cited above. EPRI's comprehensive risk-assessment framework has also been critical in supporting informed and cost-effective community health decisions. By providing objective and timely information, EPRI promotes science-based decision making on air toxics.

This project supports the PIER Program objectives of:

- Improving the environmental and public health costs/risks of California's electricity by providing science-based assessment of air toxics health and risk impacts; and
- Improving the safety of California's electricity by assessing the risk of power generation with regard to air toxics, by providing science-based assessment of air toxics health and risk impacts.

Proposed Outcomes:

1. Provide advanced tools and data to evaluate public exposure to mercury and other substances, including dioxins, with significant non-inhalation exposure routes.
2. Quantify atmospheric mercury concentrations and deposition in time and space to establish local versus regional/global influence.
3. Evaluate natural mercury emissions to provide a more accurate context for perspectives on power plant mercury emissions.

4. Determine source-receptor relationships for air toxics (with emphasis on mercury).
5. Assess health effects of nickel exposure.
6. Assess health effects of exposure to arsenic and other air toxics.
7. Provide data enhancements to the Mercury Cycling Model System.
8. Update and refine the Comprehensive Risk Assessment Framework for Toxics (CRAFT) model.
9. Evaluate ecosystem effects of mercury exposure by performing an ecological risk assessment of mercury impacts on fish-eating wildlife.
10. Determine environmental consequences of ecological and human exposure to multiple toxic agents, including arsenic, mercury, and selenium.
11. Conduct a Tailored Collaboration entitled "Risk Evaluation of Chemicals Used in the Photovoltaic Industry in California" in order to identify chemicals used in PV cells and their potential for release to the environment, and to identify PV cell technologies that have a relatively lower toxic risk compared to other cell types.

Actual Outcomes:

1. The EPRI TRUE multimedia model was extended for exposure to dioxins, by specifying congener-specific dynamics, and was adapted to the Mercury Cycling Model for lake-specific outcomes.
2. Quantifying atmospheric mercury concentrations and deposition.
 - Information was compiled from continuous measurement of wet deposition of mercury at the Covelo, California, deposition monitoring station.
 - Field measurements of mercury source terms were conducted in central coastal California and at sites in the eastern Sierra, which were disturbed by mineral recovery operations over the last 150 years.
3. Natural mercury emissions were evaluated, and a research project by EPRI staff was published in 2000, indicating contributions to mercury deposition by background emissions.
4. Additional case studies and a national study were carried out, establishing the contribution of local and international sources to U.S. mercury deposition. A report was issued in December 2000.
5. A report was published on the comparative carcinogenicity of nickel compounds.
6. Proceedings were published from the Fourth International Conference on Managing Hazardous Air Pollutants.
7. D-MCM 1.0 was released for the Dynamic Mercury Cycling Model.
8. Additional specialized modules for CRAFT were developed in case studies. Full development has been postponed by resource limitations.
9. Extensive work on ecosystem risk is under way, with published results in 2000 on fish levels of mercury and on levels and effects in avian fauna.
10. Proceedings were published from the Fourth International Conference on Managing Hazardous Air Pollutants.
11. A final report is expected to be published in mid-2001.

Status:

The Commission's participation in this target ended as of December 31, 1999. Participation in the Tailored Collaboration ended December 2000.

PIER Energy Systems Integration Subject Area Technical Review, November 21 and 22, 2002.

Outreach and Information Sharing Examples

1. The Valley Group

The purpose of this project is to demonstrate the feasibility of implementing real-time transmission line ratings for Path 15, which is one of the most complex gates in the California transmission system. Path 15 consists of six transmission lines located between central and southern California within PG&E's service territory. This project investigates the feasibility of providing real-time transmission line ratings by monitoring the conductor tension and environmental factors for a multiple transmission line path and communicating the real-time data to PG&E and the system operators at the ISO. This project is also unique because it provides a calculated real-time rating for the path directly to the system operators, as opposed to previous systems which store data for collection and later analysis. Finally, this project will also identify other possible paths in California which could benefit from real-time thermal ratings.

Conferences:

T&D World 2000, Indianapolis, May 7, 2002 "Dynamic Ratings for California's Path 15"

Short discussions and descriptions of dynamic ratings of Path 15:

IEEE Summer Power Meeting, 2002, Chicago, IL, July 23, 2002.
Short verbal presentation at WG on Transmission Conductors

CIGRE Report Session of SC 22 and meeting of WG22.12 (Electrical Aspects of Conductors)

Utility presentations:

To PG&E, May 27 and July 28, 2002, San Francisco, CA.
To SDG&E, July 30, 2002, San Diego, CA.

Articles:

EnergyPulse.net (electronic news magazine): "Alleviating Constraints on California's Path 15", Oct. 4, 2002, by Timo Seppa (VP-Operations of TVG)

(Part of) Presentation by Ron Stelmak (VP-Marketing of TVG) "Real Time Management of Transmission Lines", SERC Fall Meeting, October 17, 2002, New Orleans, LA

2. CERTS

The purpose of this project is to address the transition of California's electricity supply and delivery infrastructures from vertically integrated, utility-controlled organizations to deregulated, market-driven institutions. Power supply, network management and control systems are being driven to find new solutions to the traditional methods used to ensure stable power flows, frequency and voltage control. This project will provide integrated research and technology development that will help produce quicker and more flexible options for meeting the reliability, stability and ancillary service needs of California's electricity consumers

CEC PIER-funded presentations (* denotes a major external presentation).

* "Instantaneous Monitoring and Protection of the National Electricity Grid." Presented to University of California, Science and Technology Panel, Livermore, CA, 31 January 2002 by J. Eto.

* "The CERTS Microgrid." Presented to CEC DER Microgrid Workshop, Sacramento, CA, 2 May 2002 by R. Lasseter.

"Spinning Reserve from Pumping Load." Presented to California Dept of Water, Sacramento, CA on 23 July 2002 by J. Kueck and B. Kirby.

"The CERTS Microgrid." Presented to the Energy System Evaluation Study Group, a visiting party of Japanese gas industry executives, Berkeley Lab, 16 Sep 2002 by C. Marnay.

"Summary of Real Time System Monitoring and Control Activities and Accomplishments and Current Plans for CERTS/EPRI Electric System Reliability Project." Presentation for John L. Geesman, Commissioner, California Energy Commission, Sacramento, CA, 25 September 2002 by J. Eto

"Integration of Distributed Energy Resources. Presented at CADER, 4th Annual International Symposium on Distributed Energy Resources, San Diego, California, November 11, 12 2002.

National Energy and Environmental Capital Forum "11th National Capital Forum": Walnut Creek, California, March 2002

-National Science Foundation (NSF)/Electric Power Research Institute (EPRI) "Global Dynamic Optimization of the Electric Power Grid": Playacar, Mexico, April 2002

-Pacific Energy Innovation Association (PEIA) "Charting Our Energy Future: Waste Not, Want Not": Vancouver, British Columbia, April 2002

-Strategic Research Institute "Transmission: Operation & Planning": Washington, D.C., April 2002

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-National Academy of Science (NAS) " Power Plays: Shaping America's Energy Future": Washington D.C., October 2001

-California Commonwealth Club "Don't be left in the Dark: A Plan to Help Solve California's Power Crisis": San Francisco, California, August 2001

Presentations Related to CEC PIER-sponsored CERTS activity

Full two-days course on the Operator Training Simulator (OTS & STEMS), Short Course by QTS and DSI, "Simulator-Based Training & Studies for Dispatchers and Market Administrators" Pasadena, California. A. Debs and C. Hansen (DSI) and Sarah Lutterodt (QTS). May, 2000

Several lectures and hands-on training, Tutorial to the California ISO, "Customization of the EPRI ANNSTLF to the CA-ISO". A. Debs and D. Paravan (DSI). December 10, 2000

"Simulation Environment for Development and Testing of Plug Compatible Power Applications", 34th Hawaii International Conference on System Sciences. Robin Podmore (ISC), Marck Robinson (PowerData Corp), Anjan Bose (Univ.of Washington). January 4, 2001.

"Simulation Models for Short-Term Electricity Markets (STEMS)", Short Course by DSI, "Modern Power Systems Control & Operation in the Restructured Environment" Cambridge, UK. A. Debs, DSI. April 23, 2001.

"Simulation Models for the Evaluation of Ancillary Services Markets (STEMS)", Short Course by DSI, "Ancillary Services in Restructured Electricity Markets" Cambridge, UK. A. Debs, DSI. April 23, 2001.

Operator Training Simulator for Training and Studies, Short Courses by DSI, "Distribution Management Systems I&II" Cambridge, UK. C. Hansen (DSI). April 23, 2001.

Full two-days course on the Operator Training Simulator (OTS & STEMS), Short Course by QTS and DSI, "Simulator-Based Training & Studies for Dispatchers and Market Administrators" Fort Worth, Texas. May, 2001. A. Debs and C. Hansen (DSI) and Sarah Lutterodt (QTS).

"Introduction to EPRI Common Information Model", Eleventh EPRI OTS Working Group Meeting, Dallas TX. Robin Podmore (ISC), Chuck Hansen (DSI). May 3, 2001.

"Simulation Models for the Evaluation of Ancillary Services Markets (STEMS)", Short Course by DSI, "Ancillary Services in Restructured Electricity Markets" Montreal, Canada. A. Debs, DSI. May 14, 2001.

“Simulation Models for Short-Term Electricity Markets (STEMS)”, Short Course by DSI, “Modern Power Systems Control & Operation in the Restructured Environment”, Montreal, Canada. A. Debs, DSI. May 14, 2001.

“Simulation Models for Short-Term Electricity Markets (STEMS)”, Short Course by DSI, “Information & System Technologies for Power System Operation, Planning & Trading” Montreal, Canada. A. Debs, DSI. May 14, 2001.

Operator Training Simulator for Training and Studies, Short Courses by DSI,
“Distribution Management Systems I&II” Montreal, Canada. C. Hansen (DSI). May 14, 2001.

“Common Data Source Application Program Interface”, NERC Common Power System Modeling Forum. Robin Podmore (ISC). May 17, 2001.

“Implementation of the EPRI ANNSTLF at the CA-ISO (ANNSTLF)”, EPRI-ANNSTLF Users Group Meeting, Vancouver, BC, Canada. A. Debs (DSI). May 31, 2001.

“Computing Environment for Integrating EPRI Applications and CIM at CAISO”, EPRI Grid Operations and Planning advisory Meeting. Robin Podmore (ISC). June, 2001.

“EPRI's Dynamic Thermal Circuit Rating Software - DTCR Version 3.0”, EPRI Increased Power Flow WG meeting. Dale Douglas (Power Delivery Consultants, Inc.). June 4, 2001.

“Integrating EPRI Applications with CIM at CAISO”, Meeting EPRI Grid Operation and Planning Advisors. Robin Podmore (ISC). June 13, 2001.

“Simulation Models for the Evaluation of Ancillary Services Markets (STEMS)”, Short Course by DSI, “Ancillary Services in Restructured Electricity Markets” Salzburg, Austria. A. Debs, DSI. July 9, 2001.

“Operator Training Simulator for Training and Studies”, Short Courses by DSI, “Distribution Management Systems I&II” Salzburg, Austria. C. Hansen (DSI). July 9, 2001.

“Simulation Models for the Evaluation of Ancillary Services Markets (STEMS)”, Short Course by DSI, “Ancillary Services in Restructured Electricity Markets” San Francisco, CA. A. Debs, DSI. September 17, 2001.

“Operator Training Simulator for Training and Studies”, Short Courses by DSI, “Distribution Management Systems I&II” San Francisco, CA. C. Hansen (DSI). September 17, 2001.

Short Term Power Market Simulation, EPRI Product Line Council Meeting. Robert Entriken (EPRI). October, 2001.

“Simulation Models for Short-Term Electricity Markets (STEMS)”, Short Course by DSI, “Modern Power Systems Control & Operation in the Restructured Environment” Budapest, Hungary. A. Debs, DSI. October 22, 2001.

“Simulation Models for Short-Term Electricity Markets (STEMS)”, Short Course by DSI, “Information & System Technologies for Power System Operation, Planning & Trading” Budapest, Hungary. A. Debs, DSI. October 22, 2001.

Several Tutorial Lectures (STEMS and ANNSTLF), Short Course by DSI: Electricity Market Simulation and Price Forecasting. Budapest, Hungary. A. Debs, DSI. October 22, 2001.

“Introduction to EPRI Common Information Model”, EPRI Rio Conference. Robin Podmore (ISC). November 27, 2001.

One-Day Pre-Conference Seminar, “Introduction to the Operator Training Simulator and Its Applications for Dispatcher Training and Emerging Market Studies (OTS & STEMS), The First EPRI Latin American Conference & Exhibition: Toward a Mature Electricity Market Through Technology, R&D and Business Vision, 2001, Rio de Janeiro, Brazil. A. Debs and C. Hansen (DSI) and Sarah Lutterodt (QTS). November 27, 2001.

Data Pre-Filtering for the EPRI-ANNSTLF (ANNSTLF), Workshop on Demand Forecasting, sponsored by ONS, Brazil, Rio de Janeiro, Brazil. A. Debs (DSI). December 2, 2001.

“Building Plug and Play Power Applications using Abstract Object Modeling”, 35th Hawaii International Conference on System Sciences. Marck Robinson, Chris Mosier, Fabiola de la Pena (PowerData Corp.), Robin Podmore (ISC Corp.). January 7, 2002.

EPRI's Dynamic Thermal Circuit Rating Software - DTCR Version 3.0, EPRI Increased Power Flow WG meeting. Dale Douglas (Power Delivery Consultants, Inc.). January 17, 2002.

“Electricity Markets and Their Study by Means of Training Simulators (STEMS)”, IEEE-CS, Atlanta Section. A. Debs (DSI). January 30, 2002.

“Operator Training Simulator Applications to Market Simulation (STEMS)”, EMS Users' Conference, Albany, New York. A. Debs (DSI). April 10, 2002.

“Using PI for Forecasting, Training Simulators and Market Simulation (ANNSTLF & STEMS)”, PI Users Conference, Albany, New York. A. Debs (DSI). April 11, 2002.

"Highly Reliable Provision of Electricity Under Real-Time Performance Conditions: Mills/Delft Project on Networked Reliability in Critical Infrastructures--Findings from California", Joint Conference of the California Public Utilities Commission and the Goldman School of Public Policy, UCB. Emery Roe (Mills College), Michel van Eeten (Mills College). April 19, 2002.

"Introduction to EPRI Operator Training Simulator", Southwest American Power Dispatcher Association Meeting. Robin Podmore (ISC). April 30, 2002.

"Using the PC-Based OTS for Operator Training at CAISO", EPRI OTS User Group Meeting. Jim Fee (CAISO). May 29, 2002.

EPRI OTS Demonstration and Tutorial, EPRI OTS Working Group Meeting. Robin Podmore, Mike Terbrueggen, Jim Fee, Paul Steinberger. May 30, 2002.

Networked Reliability in California's Electricity Grid: Findings from a Recent CEC/LBNL/EPRI report, Meeting with CAISO middle level and control room managers. Emery Roe (Mills College). Paul Schulman (Mills College). June 5, 2002.

"Optimization of Weather Station Weights Using the EPRI-ANNSTLF (ANNSTLF)", Balkan Power Conference, Belgrade, Yugoslavia. D. Paravan, A. Debs, C. Hansen (DSI), D. Becker (EPRI), P. Hirsch (EPRI) and R. Golob (DSI). June 21, 2002.

"Short-Term Market Simulation (Tutorial) (STEMS)", Short Course by DSI: "Modern Power Systems Control and Operation in the Restructured Environment" Montreal, Canada. A. Debs (DSI). July 19, 2002.

Networked Reliability in California's Electricity Grid: Findings from a Recent CEC/LBNL/EPRI report, Meeting with CAISO senior executive officers. Emery Roe (Mills College) Paul Schulman (Mills College). July 30, /2002.

"Optimization of Multiple Weather Stations in a Single ANNSTLF Region (ANNSTLF)", ANNSTLF Users Group Conference. A. Debs and D. Paravan (DSI). July 30, 2002.

"Integration of ANNSTLF Using CIM (ANNSTLF)", ANNSTLF Users Group Conference. C. Hansen (DSI). July 30, 2002.

"ANNSTLF Activities by DSI (ANNSTLF)", ANNSTLF Users Group Conference. A. Debs (DSI). July 31, 2002.

"EPRI's Dynamic Thermal Circuit Rating Software - DTCR Version 3.0", EPRI Increased Power Flow WG meeting. Dale Douglas (Power Delivery Consultants, Inc.). August 8, 2002.

Networked Reliability in California's Electricity Grid: Findings from a Recent CEC/LBNL/EPRI report, Presentation to Todd LaPorte and Gene Rochlin, UC Berkeley professors. Emery Roe (Mills College), Paul Schulman (Mills College). August 27, 2002.

Networked Reliability in California's Electricity Grid: Findings from a Recent CEC/LBNL/EPRI report, Fall colloquium presentation to the Energy Resource Group at UC Berkeley. Paul Schulman (Mills College). September 18, 2002.

"Short Term Electricity Market Simulator (STEMS)", EPRI Advisory Council for Grid Operations and Planning. Peter Hirsch (EPRI), Robert Entriken (EPRI). October 1, 2002.

"Short-Term Market Simulation (Tutorial) (STEMS)", Short Course by DSI: "Modern Power Systems Control and Operation in the Restructured Environment" Lake Como, Italy. A. Debs (DSI). October 2, 2002.

Several Tutorial Lectures (STEMS and ANNSTLF), Short-Course by DSI: "Electricity Market Simulation and Price Forecasting". A. Debs (DSI), P. Hirsch (EPRI), R. Podmore (ISC), M. Ahmad (Dominion Power), L. Szot (CA-ISO). October 4, 2002.

Networked Reliability in California's Electricity Grid: Findings from a Recent CEC/LBNL/EPRI report, Meeting with the CPUC Strategic Planning Unit and invitees. Emery Roe (Mills College), Paul Schulman (Mills College). October 4, 2002.

"How the EPRI OTS Can be Used to Model Switching Operations", EPRI Safety Switching. Robin Podmore (ISC). October 8, 2002.

"Managing Shut down and Start Up of Power Systems Under Attack", Global Foundation Conference on Addressing Energy System Vulnerabilities. Robin Podmore (ISC). October 10, 2002.

"A Case Study: Integrating EPRI Operator Training Simulator with CIM", EPRI Transmission and Substation Target Working Group Meeting. Robin Podmore (ISC). October 11, 2002.

3. Development of Interconnection Standards and Case Studies (FOCUSII)

The purpose of this project is to provide a program of monitoring, data collection, analysis and reporting for selected Distributed Generation (DG) systems chosen for diversity related to generation, distribution grid and customer impact concerns. Also through this project, information will be disseminated to the Interconnection Workgroup to revise California's Rule 21 requirements to expand types of different applications eligible for "simplified interconnection". Finally, this project will develop the specifications for a separately developed California certification database for DG systems that are certified for certain

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applications. The certification database will streamline the interconnection process and reduce costs.

Presentations Related to CEC PIER-sponsored FOCUS II activity

ESI staff participated in the California Power Authority's DG Workshop on Oct. 25th. in Sacramento. The purpose of the workshop was to coordinate DG related activities among state agencies and with other stakeholders such as developers, manufacturers and utilities. Staff presented what research is being conducted in the PIER program to assess how DG impacts the transmission and distribution system, what benefits DG can provide to the system, and how benefits can be quantified and monetized. Participants are interested in research results providing analytical data for DG ratemaking proceedings ongoing at the CPUC.

4. Development of a Real-Time Monitoring/Dynamic Rating System for Overhead Lines

This project develops a monitoring system which provides instantaneous information to electric grid operators about monitored transmission lines' power-carrying capacity and safety code compliance. The system provides real time monitoring to ensure power line ground clearance requirements are met and calculates the maximum power transfer capability of monitored lines based on actual position of the conductor. Assuring maximum power transfer capability over existing lines increases the efficient use of overhead transmission lines and reduces the need for new power lines.

Presentations Related to CEC PIER-sponsored RTM activity

“Finding ‘Hidden Capacity’ in Transmission Lines” – By Blake forbes, Public Service Company of New Mexico, and Dale Bradshaw and Fisher Campbell, Tennessee Valley Authority. Transmission & Distribution World Sepetember 2002.

Southwest Research Institute (SwRI®) - helped developed video sagometer enables utilities to tap unused power line capacity. Current users of the Sagometer include Albuquerque-based Public Service Co of New Mexico, TVA, Omaha Public Power District, Long Island Power Authority, Uniondale, NY, Atlanta-based Georgia Power Co, and Birmingham-based Alabama Power Co. BC Hydro will be installing one this spring(2002), and other utilities are planning installations before summer.- Copyright Platts 2000-2002

5. Sagging Line Mitigator (SLiM)

The purpose of the SLIM project is to develop and test a sagging line mitigator to automatically counteract the sagging of high voltage transmission lines due to high ambient temperature and current flows. The product to be developed has the potential to revolutionize treatment of overhead transmission lines for both retrofitting of existing lines and construction of new lines. It will significantly reduce the risk of forest fires and brownouts caused by sagging lines, increase the efficiency of energy transfer, delays the need for additional line capacity and delay the construction of new lines. Used on new

lines, this product will allow reduced tower height and/or increased distance between towers.

Technical Transfer activities related to the SLiM contract.

EPRI is seeking utilities to participate in demonstrations of the Sagging Line Mitigator (SLiM), a new class of transmission line hardware that eliminates hot sag clearance problems.

6. Electric System Seismic Safety and Reliability (PEER)

The purpose of this project is to develop technologies and protocols to mitigate the vulnerability of electric systems to damage caused by earthquakes. Additionally, PG&E-PEER will develop assessment techniques to evaluate damage to electric systems caused by earthquakes and to assess fiscal impacts due to the loss of electric service to the community.

Presentations Related to CEC PIER-sponsored PEER activity

The Pacific Earthquake Engineering Research Center (PEER) 2002 Annual Meeting
"Progress in Performance-Based Earthquake Engineering (PBEE) Methodology"

Energy Systems Integration Technical Review Panel Members

Richard DeBlasio, Panel Chair Technology Manager for the NREL/DOE Distributed Energy Resources Program

Mr. Richard DeBlasio is currently the Technology Manager for the NREL/DOE Distributed Energy Resources Program which includes distributed power electric system integration, thermal systems integration, thermal storage systems, high temperature super-conductivity, and communications programs at NREL in support of the DOE Distributed Energy and Electricity Reliability Program and office. Mr. DeBlasio has held various senior level technical positions at NREL for nearly 25 years which included establishing and managing the NREL/DOE Distributed Power Program and Systems Integration activities from 1998 to the 2002, and the Photovoltaics Module and System Performance and Engineering Project from 1978 to 1998 at the U. S. National Renewable Energy Laboratory (NREL). Before joining NREL (SERI) in 1978, he was a senior engineer with the U.S. Atomic Energy Commission in Washington, D.C. (1974 to 1978), a project manager with Underwriters Laboratories (1972-1974), and a member of the technical staff at Stanford University (1965-1972). Mr. DeBlasio is an electrical engineer, a senior member of the IEEE (Institute of Electrical and Electronics Engineers) and member of the IEEE Standards Board, chairs the IEEE Standards Board Coordinating Committee on Fuel Cells, Photovoltaics, Distributed Power, and Energy Storage, chairs the IEC TC82 and JCG for international standards development for Renewable Energy systems and Decentralized Power Systems, and is a member of the Board of Directors for the Global Accreditation Program and the PowerMark Corporation.

Richard R. Cirillo Group Leader for Energy & Environmental Systems Analysis Group

Dr. Richard R. Cirillo heads the Center for Energy, Environmental, and Economic Systems Analysis in the Decision and Information Sciences Division of Argonne National Laboratory. Argonne is a U.S. Department of Energy facility operated by the University of Chicago. His work has involved energy system analysis, energy economics, energy infrastructure assurance, emergency preparedness, and environmental analysis. He has been involved in both domestic and international programs. Dr. Cirillo joined Argonne in 1972. He holds a Ph.D. in engineering from New York University.

Peter Douglas
New York State Energy Research and Development Authority

Peter Douglas is the Program Manager for the Buildings R&D Group, NYSERDA where he leads a multidisciplinary team in supporting: (1) product development for energy and environmentally efficient building materials, equipment and systems including lighting, HVAC and controls; (2) demonstration of on-site energy generation technology including combined heat and power and solar thermal. He also manages a suite of programs whose objective is to increase demand response in the New York wholesale and retail electricity markets through the use of load aggregation tools, flexible load end-use technologies and time sensitive retail products. He has been with NYSERDA for 15 years.

Prior to that, was a Sr. Budget Examiner for the New York State Budget Division where he was involved with the financial management of various State programs, including capital construction, energy conservation, and debt structures.

He has authored several papers that primarily address economic selection of energy efficiency strategies.

He has advanced degrees in Architecture, Economics, Business Administration and Urban/Environmental Studies from Rensselaer Polytechnic Institute and State University of New York at Albany.

He is a Registered Architect in New York State and an adjunct professor of economics at The State University of New York at Albany.

Maurice E. P. Gunderson
Co-founder and Managing Director, Nth Power LLC

Maurice Gunderson is a co-founder of Nth Power LLC, a successful venture capital firm with a focus on investments emerging from the global restructuring of the energy industry. Prior to founding Nth Power, Mr. Gunderson spent over 20 years developing profitable products and launched five successful companies. He is a specialist in thermodynamics and energy technologies and has been instrumental in the development of cryogenic equipment, energy systems, turbomachinery, and computer-based control systems for process plants and pipeline systems. Mr. Gunderson is a patent holder and a Registered Professional Engineer.

Mr. Gunderson holds an MBA from the Stanford University Graduate School of Business (1985), a Master of Science degree in Mechanical Engineering (Thermodynamics) and a Bachelor of Arts degree in Mechanical Engineering, both from Oregon State University (1974, 1975). He was named a 1984-85 NASA Technology Fellow.

Mr. Gunderson is a member of the boards of NEOPhotonics Corporation, Metallic Power, Inc., Pentech Energy Solutions, Inc., STM Power, Inc., Pentadyne Power, Inc., H2Gen Innovations, Inc., Clean Air Partners, Inc. and CellTech Power, Inc.

Gerald Harris
Senior Practitioner - Global Business Network

Mr. Harris has been working in the energy sector in various capacities for over 20 years. He has been consulting to the industry with GBN since 1993. He started his career with Bechtel Engineers as a project finance analyst. He then spent 13 years at Pacific Gas & Electric Company where he worked in Corporate Finance, Strategic Planning, and as Director of Business Planning for the Engineering and Construction Group.

Since joining GBN he has worked with electric power companies in Europe, the U.S., Canada, and Asia, and with major oil and gas companies. He has helped these companies look at cross industry investments, commercialization of new technology, adjustment to regulatory change, and managing political risk. He is an experienced facilitator and has published articles in energy journals on future developments in the industry. Example of his relevant experiences include:

Facilitating a diverse group drawn from power companies, big industrial energy users, environmentalists, and the academic community, he recently produced a set of scenarios on long term electric market developments for the State of California.

Leading a group of eight companies from Europe and the U.S., he produced a set of scenarios on technologically driven restructuring across the energy industry. The group included oil and gas companies and electric power companies looking at emerging technological trends.

Working with a team of power companies, he facilitated the creation of scenarios on the commercialization of distributed power technologies.

Working with a major oil and gas company and an electronics component manufacturer, he facilitated scenarios on the commercialization of fuel cell technology in the automotive and stationary power sectors, and for portable applications.

Working with a team of U.S. and European utilities, he facilitated the creation of scenarios on electric industry restructuring.

Gerald received his BA in Economics from Morehouse College and his MBA from the University of Chicago. He has also trained as a facilitator with Interaction Associates.

Phil Pettingill, P.E.,
Manager of Policy Development

Phil Pettingill currently serves as the Manager of Policy Development at the California Independent System Operator Corporation (CAISO), where he plays a role in the development and implementation of CAISO policies, regarding regulatory initiatives that impact the CAISO and western market design.

Mr. Pettingill originally came to the ISO as Manager of Transmission Facilities, where he was instrumental in developing ISO standards for Transmission and Generation Maintenance. Before joining the CAISO, Mr. Pettingill held various positions with PG&E. Most recently, he was the Director of Information Systems for PG&E's Electric Transmission Business Unit; where he was responsible for the creation of business systems that supported many transmission functions, such as; Customer Services, Maintenance, and System Operation.

Mr. Pettingill is a licensed Electrical Engineer in the State of California; he earned his BSEE from California State University, Sacramento; and, his MBA from St. Mary's College, CA

Phil Pettingill resides in Granite Bay, CA, with his wife and two children.